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CER 007521

Chemical Waste Management, Inc.
ENRAC Division

cc. Steve Smith
Alan Faust
0720
CEA 8777

Chemical Waste Management, Inc.

ENRAC Division - Midwest

November 20, 1991

Mr. Gordon A. Grundmann
MONSANTO CHEMICAL COMPANY
800 N. Lindbergh Boulevard
St. Louis, MO 63167

SUBJECT: **PERFORMANCE OF TREATABILITY STUDIES FOR THE DEAD CREEK PROJECT SITE CWM-ENRAC CONTROL NO. 91-11-212**

Dear Mr. Grundmann:

The Environmental Remedial Action Division of Chemical Waste Management, Inc. (CWM-ENRAC) is pleased to present this proposal for the performance of Treatability Studies for the Dead Creek Project site. The content of this document is based upon information discussed in our meeting on November 11, 1991.

The following proposal presents CWM's ability to meet Monsanto's immediate need to perform bench scale studies in the areas of waste stabilization, solidification, and filterability. CWM has the internal resources available to perform these studies and to provide Monsanto with the proper test results to make a proper assessment of the three remedial technologies that may apply to this waste stream.

CWM-ENRAC looks forward to being selected by Monsanto to perform these treatability studies for the Dead Creek Project site. We invite you to direct any questions regarding this CWM-ENRAC submittal to any of the following CWM-ENRAC representatives:

Mark J. Leibrock	Thomas G. Binz	Ronald G. Fitzpatrick
Project Development Manager	Business Development Manager	Corp. Bus. Dev. Mgr.
(708) 361-7536	(314) 845-2525	(708) 218-1678

Sincerely,

CHEMICAL WASTE MANAGEMENT, INC.
Environmental Remedial Action Division

Mark J. Leibrock

Mark J. Leibrock, P.E.
Project Development Manager

Ronald G. Fitzpatrick (pt)

Ronald G. Fitzpatrick, C.P.G.
Corporate Business Develop. Manager

MJL/RF/plt
attachments

CER 007522

PROPOSAL
FOR
STABILIZATION/SOLIDIFICATION AND FILTRATION TREATABILITY STUDIES FOR THE DEAD CREEK PROJECT SITE

PRESENTED TO:

MONSANTO CHEMICAL COMPANY
800 N. LINDBERGH BOULEVARD
ST. LOUIS, MISSOURI 63167

SUBMITTED BY:

CHEMICAL WASTE MANAGEMENT, INC.
ENRAC DIVISION
7250 W. COLLEGE DRIVE
PALOS HEIGHTS, IL 60463

CWM-ENRAC CONTROL NO. 91-11-212

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SECTION 1.0

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1.0 TREATABILITY TESTING INFORMATION

CWM-ENRAC is pleased to provide the following information to Monsanto in response to their request for bench studies on waste material originating at the Dead Creek project site in Sauget, Illinois. We are pleased to inform Monsanto that CWM-ENRAC can provide Monsanto with bench studies for waste stabilization, solidification, and filterability through CWM-ENRAC's Research and Development division.

The following sections provide information related to the approach to these tests, in addition to Monsanto requirements and associated costs.

1.1 Testing Procedures

1.1.1 Introduction

Chemical Waste Management has developed extensive experience in utilizing solidification/stabilization and filtration techniques for a wide variety of waste streams. The bulk of the studies are performed at CWM's Research Center locations at Geneva and Riverdale, Illinois. Together, these facilities form the industry's largest analytical, research, and development operation. They are dedicated to providing analytical support to regional laboratories, duplicate analysis for quality assurance/quality control at our fixed based facilities and at remedial sites, assessment of alternative technologies for waste treatment and disposal, and research and development into new and innovative processes and technologies for future applications. The work performed by our Research Center is then transferred to both CWM facilities and remedial operations.

CWM develops custom solidification/stabilization and filtration formulations, processes, and systems on a project specific basis. The typical solidification/stabilization reagents used are generally based on cement, pozzolans, or combinations thereof. Mix ratios depend on the solids content, organic content, and other characteristics of the waste. CWM specializes in the use of minor additives and control of process parameters to counteract the presence of constituents in the waste which might inhibit the setting and curing reactions of the solidification/stabilization reagents.

CWM also is especially cognizant of the importance of controlling weight and volume increase. Frequently our formulations will be determined by this factor. Products often are formulated to meet exact physical and chemical specifications.

Cement and/or pozzolanic based materials are typically the reagents used in formulating the proper solidification/stabilization system because they lend themselves to cost-effective solutions. In cement-based systems, Portland cement provides the proven, stable matrix for creation of a solid, soil-like material suitable for landfill. The pozzolanic systems which CWM used provide much the same properties. Both cement and pozzolan based systems have been used for at least 20 years to solidify/stabilize more than 10,000,000 tons of waste.

In active field operations, the CWM stabilization program specified for a given project will involve a wide range of concentrations and constituents. In these operations, we optimize the mix ratios to achieve the best results at the lowest cost. The reagents are added and mixed with the waste at the optimum ratio selected after consideration of test results, site specific conditions, and long term stability of the treated waste. These elements, based on our extensive experience, are key considerations in the development of CWM stabilization/solidification treatability studies.

CWM-ENRAC utilizes various bench-scale dewatering techniques to design sophisticated sludge processing and dewatering technologies. These bench-scale treatability studies are utilized for the optimization of conditioning agents, filtration aids, cake firmness, filtrate quality, filtration times, and various other parameters.

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Bench scale testing is an important aspect of waste management from a design viewpoint. In order to adequately predict dewaterability on mobile processing units, it is necessary to characterize and define dewatering and processing parameters on a bench scale. In addition to predicting the dewaterability of the sludge, bench scale testing identifies any health and safety concerns that may be present in handling and processing the material.

In active field operations, CWM-ENRAC mobile dewatering systems allow CWM-ENRAC to produce a consistent filter cake and filtrate while feed stock varies throughout each project. By monitoring process variables, preconditioning adjustments are made to parameters such as solids content, water/solids cohesiveness and viscosity resulting in consistent output from the dewatering unit. The adequacy of treatment is monitored and evaluated by CWM-ENRAC's technicians. A properly treated waste produces a cohesive, dry filter cake and a clear filtrate. CWM-ENRAC's ability to capture solids of one micron and greater will make solids' separation more efficient. The cake will pass a paint filter test. It is important to note that the cake will not be thixotropic and, therefore, will not release liquid during transportation. These elements, based on our extensive experience, are key considerations in the development of CWM filtration treatability studies.

1.1.2 Solidification/Stabilization

Various solidification/stabilization systems consisting of pozzolanic materials and proprietary admixtures have been selected for consideration, based on the supplied waste characterizations. A series of mixes, using various quantities of the stabilization/solidification reagents, will be made to CWM, but will be communicated to Monsanto Chemical Company as confidential business information.

In the initial formulation studies, a series of mixes, using a different quantity of each reagent in each, are made with small aliquot of waste to be tested. The reagents to be used are inorganic-based systems developed specifically for the project. Normally at least 100 grams of material is used. The amount used is based on experience with that waste and reagent, and is best expressed as the "mix ratio". Mix ratio (MR) is defined as follows:

$$\mathbf{MR} = \frac{\text{Weight of Reagent}}{\text{Weight of Waste}}$$

Before beginning the mixes, a small quantity of the waste is tested under a fume hood with the reagents to be evaluated to ascertain any potential hazards associated with the mixture; for example, violent reaction, gas evolution or rapid heat generation.

A liquid of the waste material will be weighed out into 400 ml. polyolefin jars with tight-fitting, screw caps of the same material. The expected number of aliquot, as determined by the experimental design, are all weighed at the same time and then covered until the mixes are complete. Each jar is identified with a waterproof label and a unique sample number with a permanent marker. The reagents are weighed directly into the jars, then placed onto the waste and immediately mixed in.

The waste is leveled in the jar bottom without void space, and the level marked on the outside of the jar. After treatment and compaction of the mixture, the level is marked again. The two markings are compared to a calibrated, marked jar to measure the approximate volume increase due to the treatment.

With most wastes, optimum mix ratios fall in the range of 0.1 to 1.5. A typical first-cut experimental scheme might use four reagents or reagent mixtures, each at three mix ratios. The reagents are weighed directly into the jars, then placed onto the waste, and immediately mixed in. Mixing is done with a fairly stiff, wide blade, stainless steel spatula. Mixing action depends on the waste and reagents used, and will range from a stirring action to cutting and

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scraping. Completion of mixing is based on the judgement and experience of the technician, and usually requires several minutes. During and after mixing, observations are recorded about the sample (difficulty of mixing, appearance, viscosity, presence of excess fluid, color or odor changes, heat or gas evolution, physical properties).

After mixing, the treated material is placed into a 2" diameter X 4" height mold in lifts. The height of any given lift does not exceed 1/3 of the mold height. Each lift is compacted with moderate force and the upper portion disturbed before placing the subsequent lift material into the mold. The molded material will be capped with paraffin and left undisturbed for two days, then removed from the molds and placed in sealed bags for additional curing.

After seven days of curing, unconfined compressive strength is run on the molded material. For those treated materials which exhibit greater than 50 psi unconfined compressive strength, a portion of the treated material can be subjected to leaching tests to assess metals leachability, if required.

If none of the preliminary formulations is successful for a waste material, additional formulations are attempted based on the results of the preliminary work and past experience. In addition, formulation development work is done with a mixed sample consisting of all waste types to assess the viability treating the waste materials mixed together as opposed to treating them separately.

For each waste material, the successful formulations are compared on the basis of price, reagent availability, materials handling and waste/reagent interactions to determine the most viable stabilization formulation. If required, Monsanto will be supplied with a formulation for each waste material and a sample of the respective treatment material for further testing and evaluation.

1.1.3 Filtration

The technique used first in the determination of dewaterability of a specific sludge is the leaf filter test. The leaf filter is a circular filter designed to simulate the under drain construction of a full scale pressure filter with the filter medium fastened over a grid face. The leaf filter is connected directly to a pressure source to simulate pressure filtration. This method can quickly determine whether or not a batch of sludge is properly conditioned prior to pumping the material to the press.

A second technique used in assessing a sludge's dewaterability is a bench scale simulated plate and frame filter press. This unit is utilized for evaluations of sludge conditioning materials. This unit utilizes a nitrogen gas cylinder with a pressure of up to 225 psi to simulate actual filter press operation. Various conditioning techniques and filter cloths can be evaluated using this unit.

A small trailer-mounted one cubic foot plate and frame filter press can also be brought to the Dead Creek site to perform a nearly full-scale filterability evaluation. This press is valuable in evaluating full scale operating parameters and in generating a larger volume of filter cake that can be submitted for waste profiling to obtain a disposal approval for the processed material.

Sludge conditioning utilizes two mechanisms necessary to increase sludge dewatering efficiency. The first is neutralizing charge and the other is agglomerating individual particles into larger particles. Sludge particles are negatively charged and repel each other. Sludge conditioning, by replacing trivalent ions in the outer layer of the sludge particle, reduce the net repulsive force by decreasing these negative charges. This charge neutralization allows sludge particles to agglomerate together into larger particles that are more easily filtered.

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Chemical conditioners such as hydroxides and organic polymers form small molecules that attached themselves to particles and bridge the gap between the particles to form larger particles.

Organic polymers have an advantage over inorganic conditioning agents such as ferric chloride and lime because they are easier to handle and do not contribute to increased sludge volume for disposal.

Sludge conditioning also includes the utilization of physical mechanisms to improve dewaterability. This physical mechanism is the utilization of filter aids which do not actually chemically react with the sludge, but rather add body to the sludge which creates an even cake buildup during dewatering, thereby increasing the permeability of the cake during its formation.

Based on past experience with similar waste materials, CWM-ENRAC tests various conditioning formulations to determine the most cost-effective methodology for dewatering a waste material. Each formulation is evaluated against the others on the basis of price, availability, volume reduction, cake cohesiveness, filtrate clarity, and the handling requirements of the material.

Monsanto will be supplied with the filtration treatability test results for the most promising conditioning recipe along with a sample of filter cake for further testing and evaluation.

1.2 Sample Size

CWM-ENRAC will require a minimum of one gallon of sample per waste stream, with a maximum of five gallons per waste stream. If possible, the preferred volume of sample will be two gallons per waste stream.

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1.3 Contact Person

All correspondence and samples regarding the treatability studies, will be directed to:

CHEMICAL WASTE MANAGEMENT, INC.
GENEVA RESEARCH CENTER
1950 South Batavia Avenue
Geneva, IL 60134

ATTN: Darshana Brahmbhatt
Phone: 708-513-4863

Prior to forwarding any sample materials, Ms. Brahmbhatt will supply Treatability Study Authorization numbers to be placed on each sample container.

1.4 Time Requirements

Chemical Waste Management requires six to eight weeks from when the waste samples are obtained until a formal report is submitted along with the resultant samples.

1.5 Residual Management

All residuals from the treatability studies will be properly lab-packed at the Geneva Research and Development facility and transferred to a Chemical Waste Management TSDF according to proper DOT regulations.

Once the material has been transferred to the disposal facility, the waste will be treated, if necessary, for proper disposal. According to recommendations set forth by the Research and Development facility, the material will be incinerated or landfilled at the proper Chemical Waste Management facility.

1.6 Associated Costs

The lump sum cost of the Treatability Studies is $10,959. Please note that if CWM-ENRAC is chosen as the remediation contractor to perform the actual remediation of the Dead Creek project site, and the remediation contract is awarded prior to April 1, 1992, the Treatability Studies will be performed by CWM-ENRAC at no charge to Monsanto. This offer applies regardless of the remedial technology chosen by Monsanto.

This proposal is subject to the National Agreement between CWM and Monsanto. The attached General Terms and Conditions apply.

GENERAL TERMS AND CONDITIONS

(1) This proposal and all attachments and exhibits are considered confidential and proprietary and shall not be loaned, copied, distributed or published, in whole or in part, or used for any purpose other than for which it was intended, without prior written consent of CWM-ENRAC.

(2) Invoices will be submitted by CWM-ENRAC biweekly and are payable within 15 days unless otherwise stated. Invoices not settled within 15 days are subject to 1-1/2% per month service charge on the outstanding balance.

(3) Owner is responsible for Federal, State and Local disposal and sales taxes which are not included in the project pricing.

(4) Regulatory permits which are required for the on-site portion of the project are the responsibility of the Owner unless otherwise expressed in the attachments and/or exhibits.

(5) Pricing is firm for 30 days following the date of the proposal.

(6) Any waste which the disposal facility cannot receive, treat, store, process, handle or dispose of is outside the scope of the contract and CWM-ENRAC will have no obligation to receive, treat, store, process, handle or dispose of such waste.

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SECTION 2.0

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2.0 SUMMARY OF CWM RESEARCH AND DEVELOPMENT

Attached is a summary of the services and support activities provided by CWM's Research and Development division. This summary highlights the following areas:

- CWM Technologies
- CWM Processes
- CWM Professional Profiles

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SUMMARY OF CWM RESEARCH AND DEVELOPMENT ACTIVITIES

Chemical Waste Management (CWM) maintains an extensive Research and Development function to support its operations and to provide support to its parent company, Waste Management, Inc. Headquarters are located at 1950 S. Batavia Avenue in Geneva, Illinois. Other operations are in Riverdale, Illinois and Lake Charles, Louisiana.

The current headcount at the Geneva Research Center is 91, of which over 70 are degreed engineers and scientists. Chemical engineering is the most prevalent discipline, with some mechanical and electrical engineers also on the staff. Thirteen have Ph.D.s. The average number of years of experience in the hazardous waste, petroleum or chemical process industries is 20.

At Geneva and Riverdale, R&D has laboratories to conduct exploratory research, multiple types of treatability studies, plus high bay space for larger scale pilot plant operations. New laboratory facilities (approx. 8,000 sq ft) costing about $5 million will be occupied in late 1990. Analytical instrumentation and support is available for internal guidance on projects. Our Analytical Services Department in Riverdale consists of 49 technical staff and provides extensive analytical support on a wide variety of methods, with a full QA/QC program. Machine shop and craft support is provided for equipment construction and maintenance. Extensive secretarial, computer and library support also exists. Engineering support is also available through Sirrine Environmental Consultants, a recent acquisition.

R&D is being conducted in a wide variety of areas. Some of the highlights include the following:

1. Wastewater treatment by the PO•WW•ER™ process. A fully integrated pilot plant has been designed and constructed, and is currently being operated at our Lake Charles, Louisiana site. Many runs on complex wastewaters containing organic and inorganic constituents, such as landfill leachates have been completed, with excellent results. A 50 gpm commercial facility will be installed at CWM's Emelle Alabama facility.

2. Wastewater treatment by a biological sequencing batch reactor (SBR) process. The process was piloted and the first commercial unit was started up at CWM's facility in Calumet City, Illinois. A second unit is under construction in The Netherlands.

3. Wastewater treatment by physical/chemical treatment. Developed an oxidation/filtration process to treat wastewater containing chelated nickel and other metals. Operated the process commercially to remediate a lagoon at CWM's NIES, Kansas site.

4. Remediation of organic-contaminated soils and sludges using CWM's patented X•TRAX™ thermal treatment process. Built and operated small pilot units on numerous actual RCRA and TSCA wastes, many contaminated with PCBs.

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Built and operated a five ton per day pilot plant which has operated at three sites on several different waste streams. A commercial scale, 125 ton per day unit has been built and is prepared to mobilize and operate at the Resolve CERCLA site near New Bedford, Massachusetts in the first quarter of 1991.

5. Stabilization technology. Regularly perform project-specific laboratory treatability studies to support base business and ENRAC remedial projects. Designed continuous, high throughput, transportable, stabilization systems known as "Chem-Matrix™" for CWM disposal sites and ENRAC to meet the demand of RCRA Land Disposal Restrictions. Start-up of three commercial systems are currently underway.

6. Hazardous waste incineration technology. Participated in start-up of CWM's new 150 million Btu/hr rotary kiln incinerator at Port Arthur, Texas, currently the largest hazardous waste incinerator in the U.S. Now participating in the design of several additional hazardous waste incinerators.

7. Dechlorination of PCBs and dioxin. Conducting a wide array of activities ranging from bench scale exploratory studies to participation in two commercial operations. Now constructing a demonstration facility for operation at the Resolve CERCLA site.

8. Filtration of aqueous, oily, and biological sludges. The full service Separation Technologies lab has conducted numerous laboratory and pilot scale treatability studies on a wide variety of industrial and municipal sludges. These efforts have resulted in implementation of many full-scale filtration operations by CWM's regional ENRAC divisions.

9. Vitrification. CWM was selected by ASME to manage a major industrially supported research effort to evaluate vitrification of municipal refuse incinerator ash. Several tons of ashes will be collected, size-reduced, and vitrified in a U.S. Bureau of Mines facility. CWM will direct the day-to-day activities on the project, monitor the necessary parameters, and report results.

Additional active programs involve metal recovery processes, separation technologies, oxygen-enhanced incineration, soil washing, and biotreatment processes. R&D work has resulted in several recent patents, some 25-30 presentations per year, and 8-10 articles in technical journals. The annual budget is approximately $13 million.

CWM R&D provides technical support to our operating divisions to ensure implementation of treatment processes in a timely and environmentally sound manner, while providing a broad range of treatment systems. The integration of research with practical experience in start-up and operation of commercial hazardous waste facilities, places Chemical Waste Management in a unique position to evaluate and recommend hazardous waste treatment and disposal technologies.

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SOLIDIFICATION / STABILIZATION QUALIFICATIONS

INTRODUCTION

The stabilization group of Research and Development, located at the Geneva Research Center, is directed by Mr. Jesse Conner. Jesse is a world renown expert in the field of stabilization/solidification and the author of new text book entitled "Chemical Fixation and Solidification of Hazardous Wastes." He brings over 22 years of experience to CWM. Jesse is supported by Dr. Paul Lear, and Woody Cotton, who collectively bring 16 years of environmental experience to this group. Professional profiles for these individuals are provided in Attachment 1.

To date, more than 72 laboratory stabilization treatability studies have been successfully completed since 1987 by the stabilization group. These studies have been conducted on a full range of matrices which include solids, sludges and aqueous mediums. The current emphasis of ongoing research and support efforts are in two main areas: (1) formulation development/support of CWM-owned Treatment, Storage, and Disposal Facilities; and (2) treatability studies for field support of regional ENRAC remediation projects.

CWM develops and uses custom stabilization formulations, processes and systems for specific projects. The processes are usually of a generic nature, with the reagents and additives being balanced to meet the needs of the project at the lowest possible total cost. The specific reagents used will generally be based on cement or pozzolans, or combinations thereof. All reagents and additives are commercially available materials. Mix ratios will range anywhere from 100 pounds per ton of waste treated to about 2000 pounds per ton, depending on the solids content, organic content and other characteristics of the waste.

CWM solidification/stabilization processes operate daily at a number of CWM sites. Since 1985, CWM has stabilized large volumes of wastes at its facilities covering a broad spectrum of chemical compositions and physical states. Recently, six CWM facilities were stabilizing in excess of 200,000 tons per year as a result of the first and second-third land disposal restrictions. Overall quantities of hazardous waste requiring treatment prior to land disposal have increased significantly as a result of new treatment standards for third-third wastes effective August 8, 1990. CWM facilities have stabilized more than a million tons of wastes since the landbans came into effect.

SIGNIFICANT RESEARCH ACTIVITIES

F006 Electroplating Waste Water Treatment Sludge

In response to the proposed first-third landban regulations, CWM R&D launched a large effort to determine the feasibility of stabilizing F006 constituents, as proposed by EPA as the Best Demonstrated Available Technology (BDAT) for that waste. Over 100 samples of F006 were screened to determine the typical F006 waste. From this initial screening, R&D was able to focus their effort on specific contaminants of concern. The results of this intensive effort were used by the U.S. EPA for setting the BDAT performance levels for F006 when the first-third of the landban became effective on August 8, 1988.

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K061 Electric Arc Furnace Dust

A research effort was initiated in 1988 in order to determine the ability of stabilization technology to meet proposed treatment requirements for K061 wastes. Six waste streams were evaluated to determine the general characteristics of K061 wastes, and 180 samples were analyzed and evaluated using various stabilization techniques. The relationship between leaching potential and the pH of the TCLP extract were thoroughly investigated. A strong pH relationship to metals immobilization was concluded as a finding in this study. In addition, with proper pH conditions, and the addition of a proprietary additive, delisting of the waste can be achieved in many cases.

Arsenic Stabilization

Arsenic is one of the most difficult regulated landban constituents to stabilize. It exists as many species, and in its oxide form is amphoteric, meaning it is soluble in acids and bases. Arsenic is of special concern because it is ubiquitous in hazardous wastes and conventional stabilization agents. CWM investigated the ability of conventional stabilization in reducing leachable arsenic to below the 5.0 mg/l level. To date, research has been successful in stabilizing arsenic to below 5.0 mg/l where low to medium concentrations in the raw waste exist. Significant R&D work is underway, including the development of proprietary process chemistry, to stabilize difficult, high arsenic D004 waste streams such as arsenic trisulfide.

Low Level Organics Stabilization

Many of the organic levels established in the third-third land disposal regulations are in the low level category, as are some levels which are established in the TCLP. Because of these new regulations, low level stabilization techniques are becoming more attractive for remediation and treatment. To date, there is little public information regarding organic stabilization of hazardous wastes.

CWM's stabilization group investigated the feasibility of organic stabilization as a technology earlier this year. Following the third-third proposal, CWM had agreed to provide the EPA with data concerning the treatability of hazardous waste leachate. The project was designed to provide data to the U.S. EPA for the purpose of setting new BDAT standards for hazardous landfill leachate to replace inappropriate standards resulting from application of the "derived-from" rule. As part of this agreement, CWM investigated the ability of conventional water treatment technologies in removing 231 organic compounds. These processes generated treatment residues which were found to have significant levels of BDAT organics.

The stabilization group developed four formulations to address these treatment residues. In almost every case, these formulations were capable of stabilizing the organics in the residues to below BDAT levels, with the exception of methanol.

Work is continuing in this area in cooperation with the EPA to determine the mechanisms of organic stabilization, and the applicability to the broad range of matrices including soil and debris which can commonly be encountered at a hazardous waste or remediation site.

TECHNICAL CONSIDERATIONS

CWM performs stabilization studies for all unique waste streams that CWM ENRAC encounters. Cement and/or pozzolanic based materials are usually the basic reagents used in formulating the proper stabilization system, because they lend themselves to cost-effective solutions to

problems. However, they may not be adequate or sufficient for all waste streams. CWM specializes in the use of minor formulation additives which will help overcome the inhibition of setting and curing reactions of the stabilization reagents. By careful control of reagent/additive types and mix ratios, as well as other process parameters, the Geneva Research Center has been able to custom design specific treatment methods for specific wastes on a project-specific basis. CWM has developed and maintained and extensive treatability database, which contains the results of hundreds of treatability studies to date, to provide sound, proven technical solutions.

CWM is especially cognizant of the importance of weight and volume increase due to reagents, and volume increase due to fluffing of the treated waste, when the treated product is to be transported and disposed off-site. Frequently, formulations will be determined by this factor. Products can usually be produced to exact physical an chemical i.e., leachability, specifications, provided these specifications are known in advance. Alternately, CWM can suggest performance specifications which are adequate and realistic, without introducing unnecessary cost.

PRODUCTION

The CWM-ENRAC system specified for a given project will handle a wide range of concentrations of the constituents of interest. In operation, we optimize the mix ratios to achieve the best results at the lowest cost. The reagents are added and intimately mixed with the waste at the optimum ratio selected after consideration of test results, site specific conditions, and long term stability of the stabilized waste.

Reagents are transported to the site in tanker trucks and transferred to the storage silos and tanks by enclosed pneumatic or mechanical systems to minimize dust and odor. Reagent storage silos are fitted with bag houses to collect any dust that may be emitted during the loading and transfer operations. Raw reagent is exposed to site air only after it is "in suspension" in the stabilized/fixed waste.

Mixing may be done either in-situ or by excavation and processing through a mechanical mixing system, depending on the project requirements. CWM has experience with both methods. Specific equipment is selected based on the waste, the site conditions and the disposal scenario.

CHEM-MATRIX℠ SYSTEM

Effective stabilization of toxic heavy metal components of a waste requires good feed preparation and intimate blending of the waste with proper reagents at predetermined ratios. To meet this challenge, Chemical Waste Management developed the Chem-Matrix℠ system.

This system is CWM's commercial, automated process for the controlled mixing of wastes and reagents for stabilization.

The Chem-Matrix℠ treatment system was developed by Research and Development's Chemical Process Development Group to provide a comprehensive solution to the challenges encountered in stabilizing the wide variety of industrial waste streams, largely due to the demands of the RCRA land disposal restrictions. The lead individual in R&D's Chemical Process Group for Chem-Matrix℠ is Larbi Bounini, a chemical engineer, who is assisted by engineers Tony Hammock and Joe Foley. Professional profiles of these individuals are listed in Attachment 1.

The system is a transportable, modified pugmill stabilization plant which is designed to mix solid or semi-solid materials with a dry stabilizing agent and water. The system can also be used to stabilize liquid wastes with minor modifications and controls. The system has been designed, tested, and demonstrated on a variety of metal-bearing RCRA hazardous wastes. It is modular in design to allow for construction of different versions and future modifications, depending on the specific local needs. Figure 1 shows a general process flow diagram which identifies the following:

- o Waste receiving;
- o Waste pretreatment i.e., size reduction, debris removal or destruction and chemical pretreatment; and
- o A Stabilization module.

Simple wastes may not require any particular physical or chemical pretreatment, and can be directly stabilized. Complicated wastes, such as incinerator bottom ash, soil and debris, large clinkers, and metallic objects will require a physical pretreatment step. The system can be equipped with shredders or crushers to meet the site-specific need. Wastes containing cyanides, complexed metals, and hexavalent chromium are examples where chemical pretreatment could be required. The system can be fitted with chemical pretreatment tanks, hardware, and controls needed to chemically pretreat difficult-to-treat wastes prior to stabilization.

The process control system has been designed for maximum flexibility, taking into account the complicated nature of waste flow properties. It allows for continuous, semi-continuous, or batch mode operation. The basic configuration of a full scale Chem-Matrix℠ system is shown in Figure 2.

Start-up of the first two Chem-Matrix™ treatment plants are underway at CWM's Emelle, Alabama facility, and at a site remediation in Michigan, with two more plants coming online within the next six months. Three other systems are in the Engineering phase. Several waste streams, including dry granular material, sludge and filter cake, were successfully treated through the system in Alabama which consists of chemical pretreatment and stabilization.

PRODUCT CHARACTERISTICS

Each specific project may require that the final product meet certain types of physical and chemical characteristics. In any case, no free liquid will be present. Depending on the specifications of the project, one or more of the following test and QC/QA procedures can be used:

Paint Filter Test: EPA SW-846, Method 9095

Bearing Strength: Pocket Penetrometer and Cone Index (ASTM D3441-79)

Unconfined Compressive Strength: ASTM D2166-66, ASTM D1633-84

Freeze-Thaw Durability: ASTM D4842

Wet-Dry Durability: ASTM D4843

Permeability Test With Constant Head: EM 1110-2-1906

Moisture Density Relationship: ASTM D1557-70

Volume Increase:

Consistency: (Product consistence may range from monolithic solid to friable, soil-like material, much like hard clay, which has good handling and landfill properties. Within limits, this property may be altered to meet the project conditions.)

Toxicity Characteristic Leaching Procedure (TCLP): Used to determine the mobility of both inorganic and organic constituents in wastes. Replaces the Extraction Procedure Toxicity Test (EPT) as of September 30, 1990.

Multiple Extraction Procedure (MEP) - EPA SW-846, Method 1320: Uses the old EPT as the first extraction in a series of ten extractions; the latter nine use a synthetic "acid rain" solution. This test is used primarily for delisting petitions.

Oily Waste Extraction Procedure - EPA SW-846, Method 1330: Used primarily in delisting petitions to determine the mobility of metals in oily wastes.

Long-Term Durability Tests:

ANS 16.1: This test, using deionized water, will allow the calculation of an effective diffusion coefficient, from which the mass loading of constituents to groundwater and determination of fractions leached can be determined. Tests are normally run for the full 90 days, but sometimes are attenuated to 5 days.

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Modified ANS 16.1 (MANS): This test uses site water instead of deionized water. It gives a starting point for estimating an effective diffusion coefficient to be used in mathematical modeling of the interaction between treated wastes and the actual ground water. It will also reveal the presence of any interferences from chemical reactions between the waste form and the ground water.

Sequential Batch Leaching Tests: The ANS 16.1 and MANS tests are specific examples of sequential batch leaching procedures. There are a number of other such tests which have been proposed and sometimes used, primarily in research applications.

Column Leaching Tests: These were among the earliest leaching tests used for stabilized wastes, but have never achieved any regulatory status or degree of research use.

Other Tests: Many specialized tests may be run as required by regulatory agencies, generators or in research use. Some of these are:

Acid Neutralization Capacity
Sequential Chemical Extraction
Particle Size Distribution and Morphology
Flexural Strength
Moisture/Density Relationship
Volume Increase
Bulk Density

GCG.SS/143 Rev/093090

CER 007546

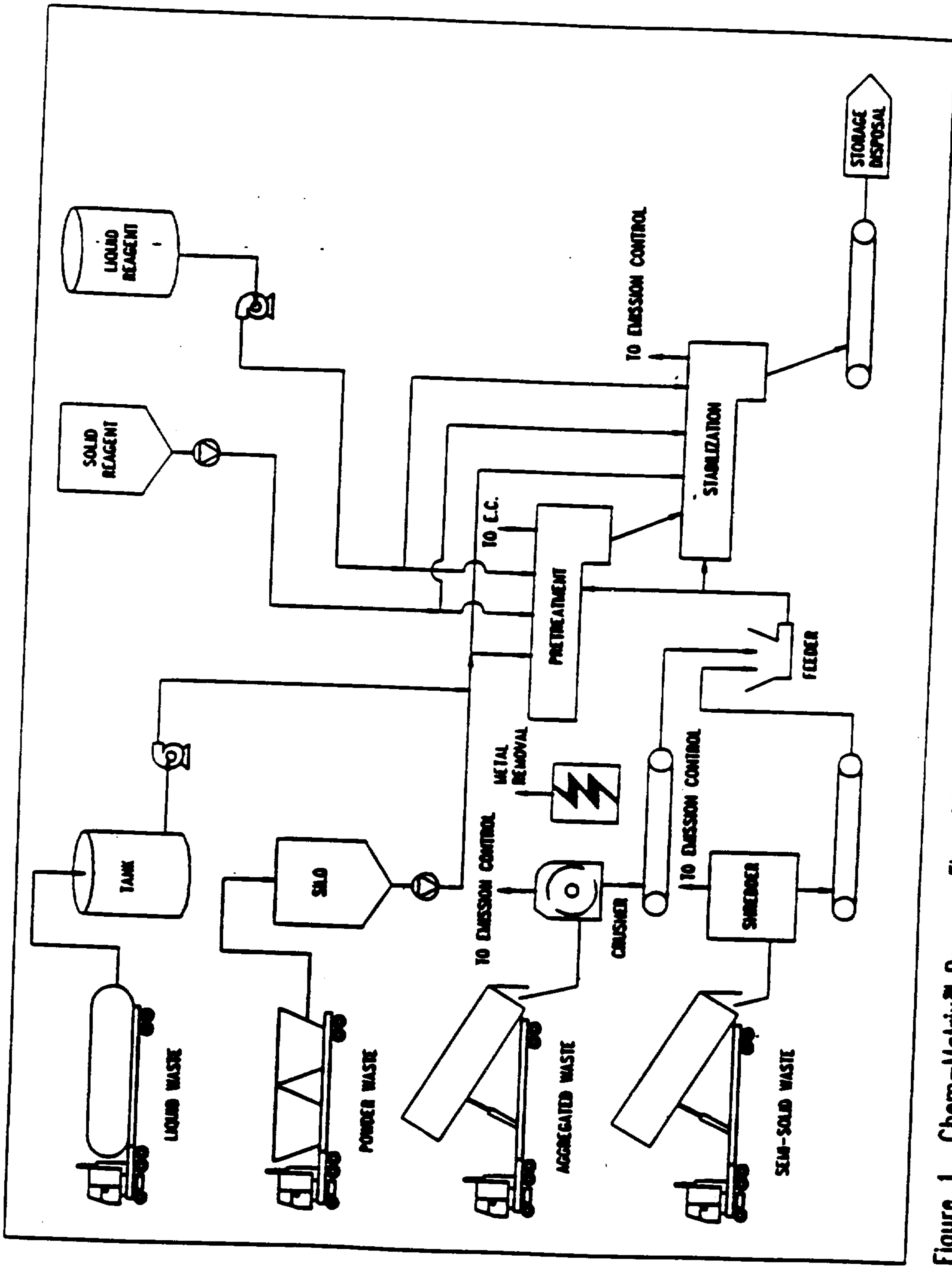
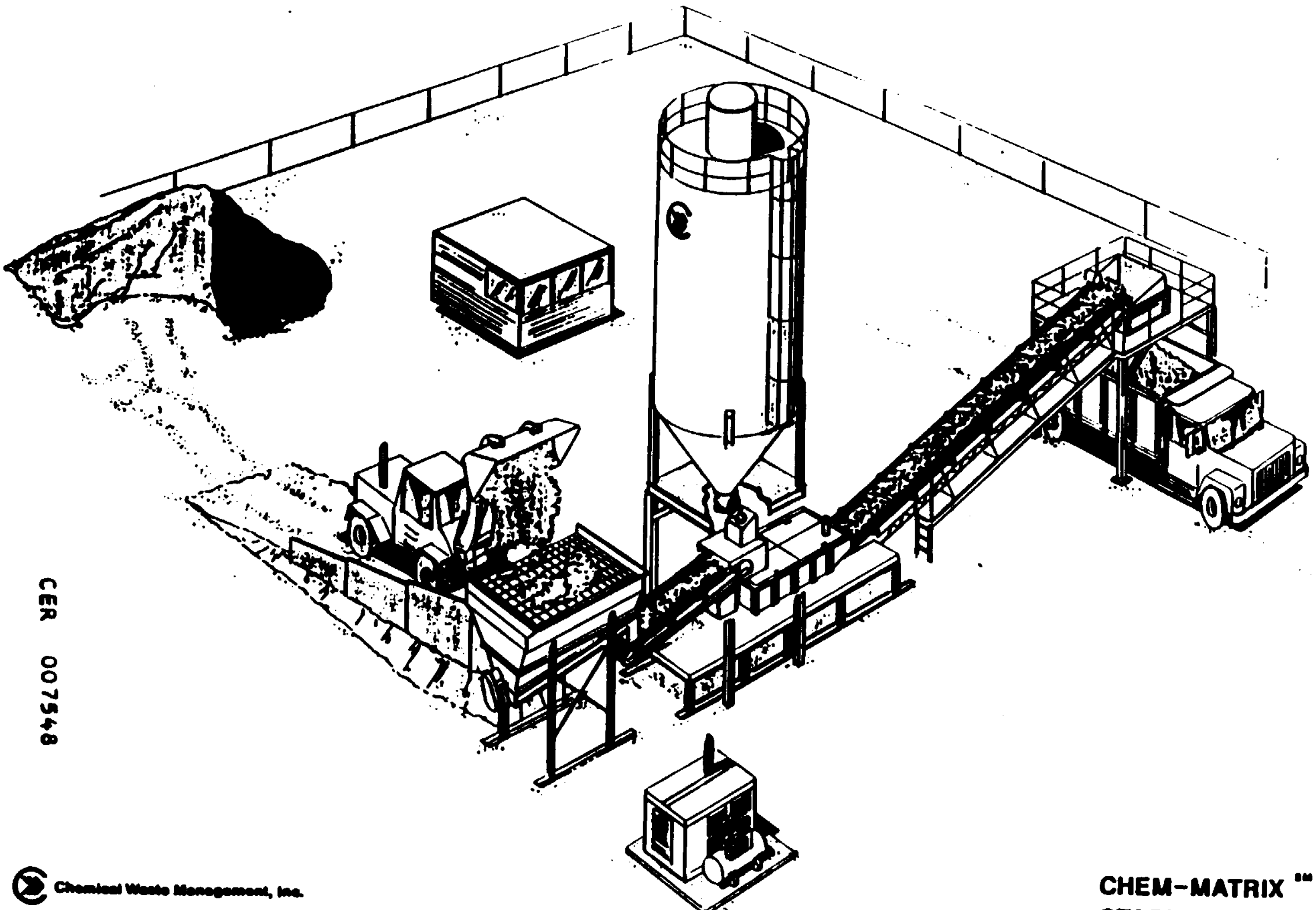


Figure 1. Chem-Matrix™ Process Flow Diagram

CER 007547



Chemical Waste Management, Inc.

CHEM-MATRIX SM
STABILIZATION PROCESS

RESEARCH

PROFESSIONAL PROFILE

JESSE R. CONNER
SENIOR RESEARCH SCIENTIST, STABILIZATION SYSTEMS,
CHEMICAL WASTE MANAGEMENT, INC.

EDUCATION

- B.S. Chemistry (Honors), Carnegie-Mellon University, 1954

CURRENT PROFESSIONAL HIGHLIGHTS

- Regulatory review and interaction with EPA on stabilization
- Evaluation/development of new and innovative stabilization systems for second third and third third "Land Ban" requirements
- Supervision of treatability studies on stabilization

EXPERIENCE

Professional Experience: 36 yrs. Waste or Environmental Fields: 22 yrs.

Mr. Conner co-founded several companies in the hazardous waste stabilization field, including the original Chemfix Corp. and SolidTek, Inc., and has also consulted with many firms in this area before coming to CWM in 1987. He has been active in research, testing, commercial development, operation and management of hazardous waste treatment for 20 years, and is a recognized expert in waste stabilization and fixation. During this period he has:

- Developed and operated the first mobile hazardous waste treatment service in the U.S.
- Written one of the early Part B permit applications for a central TSD facility.
- Started up one of the first fixed-site stabilization operations in the U.S.
- Operated companies which completed on-site stabilization at more than 100 remedial projects in the U.S., England, France, Japan and Canada.
- Conducted stabilization treatability studies on several thousand liquid and hazardous waste streams.
- Developed general formulations for stabilizing F006 electroplating waste to first third "Land Ban" requirements, implemented at CWM sites, then aided in stabilizing "problem" F006 wastes. Conducted similar program on K061 electric arc furnace dust.

AFFILIATIONS, AWARDS

- ACS, ASTM, ASM
- Winner of the "IR-100 Award," 1970, and the "John C. Vaaler Award," 1972 for the Chem-Fix Process

CER 007549

PUBLICATIONS

About 15 technical papers, numerous technical presentations, eight U.S. patents and several more pending; author of one book on chemical fixation and solidification (published by Van Nostrand Reinhold).

RESEARCH

PROFESSIONAL PROFILE

SHERWOOD M. COTTON
RESEARCH CHEMIST R & D, STABILIZATION SYSTEMS,
CHEMICAL WASTE MANAGEMENT, INC.

EDUCATION

- M.S. Chemistry & Physics, Roosevelt University, 1958
- B.S. Chemistry, Roosevelt University, 1950

CERTIFICATION

- State teaching certificate for Chemistry and Physics in the high school.

CURRENT PROFESSIONAL HIGHLIGHTS

Mr. Cotton is responsible for conducting chemical experiments to determine how to stabilize the various waste streams, operating the various types of test equipment and performing analysis of leachate solutions.

EXPERIENCE

Professional Employment: 40 yrs. Waste or Environmental Fields: 13 yrs.

- Senior Research Chemist (17 years) at the Harvey Technical Center when operated by Sinclair Research 1956-1963 and by Atlantic Richfield 1976-1985 until it closed.
  Responsibilities during both terms were operating bench and pilot plant test equipment. Major projects included:
  - Air oxidation
  - Radiation chemistry
  - Coal cleaning
  - Catalyst development
  - Organic Chemistry
  - Petrochemicals Process Development
  - Corrosion prevention – heat exchangers
- American Can Company – Printing Division (10 years). Chief Chemist and manufacturing manager of printing inks, chemicals and plate departments. The Ink Department has about 20 employees which produced about 2 million pounds per year of offset ink for six large printing plants. In addition, this job required solving the printing operational failures caused by the ink, paper, or press variables.
- Continental Can – R & D Labs, Ink Group (2 years). Technical Service Manager of the U.V. curable can coatings. Formulated the inks and coatings for U.V. operations.
- Part-time Chemistry instructor for City College of Chicago and Triton College. Also, a short period of high school science teaching.

AFFILIATIONS

- American Chemical Society
- Catalyst Club of Chicago
- Technical Association of Graphic Arts
- Graphic Arts Technical Foundation

CER 007550

PROFESSIONAL PROFILE

PAUL R. LEAR, Ph.D.
CHEMIST II, CHEMICAL PROCESS DEVELOPMENT,
CHEMICAL WASTE MANAGEMENT, INC.

EDUCATION

- Post Doctorate, Michigan State University, 1987
- Ph.D. Soil Chemistry/Mineralogy, University of Illinois, 1987
- M.S. Soil Chemistry/Mineralogy, University of Illinois, 1984
- B.S. Soil Science, University of Nebraska, Lincoln, 1982

CURRENT PROFESSIONAL HIGHLIGHTS

Dr. Lear is a member of the Stabilization Group and is responsible for determining the chemical processes occurring during the stabilization/fixation of inorganic and organic constituents of hazardous waste matrices.

EXPERIENCE

Professional Experience: 8 yrs. Waste or Environmental Fields: 3 yrs.

- Lab Manager and Study Director, EPL/Bio-Analytical Services, Decatur, IL. Directed studies in the analysis of pesticide residues in soil, water and crop matrices. Supervised and guided 4 chemists and 10 technicians and oversaw the day-to-day scheduling of the laboratory. Familiar with EPA GLPs.
- Post Doctoral Research Associate, Michigan State University. Conducted research in the area of catalysis support systems derived from acid-treated clay minerals. Characterized the materials using spectroscopic and physical techniques.

AFFILIATIONS

- American Chemical society
- American Society of Agronomy

PUBLICATIONS

Author of 7 scientific publications and 1 book chapter.

CER 007551

RESEARCH

PROFESSIONAL PROFILE

LARBI BOUNINI
PROJECT MANAGER, CHEMICAL PROCESS DEVELOPMENT,
CHEMICAL WASTE MANAGEMENT, INC.

EDUCATION

- M.S. Chemical Engineering, Illinois Institute of Technology (1974)
- B.S. Chemical Engineering, University of Rochester (1969)

CURRENT PROFESSIONAL HIGHLIGHTS

Mr. Bounini is responsible for developing and implementing process technology to stabilize hazardous wastes. Other responsibilities include process development for coal tar treatment, waste acid neutralization and stabilization of hazardous wastes incinerator ash.

EXPERIENCE

Professional Employment: 21 yrs. Waste or Environmental Fields: 5 yrs.

- Project Manager/Research Manager - USG Corporation Research Center, Libertyville, IL. Responsible for developing a torroidal bed reactor system for use in calcination of solids. Managed a group of seven professionals engaged in process development and optimization of rotary kiln calcination, pressure hydration and size reduction of inorganic solids. (1984 - 1988)

- Research Associate/Senior Research Staff Member/Research Staff Member - USG Corporation Research Center, Libertyville, IL. Led a multi-faceted project to reduce cost in the manufacture of gypsum products. Conducted fundamental studies in decomposition and hydration of solids, and mixing and rheology of concentrated slurries to determine process optimum conditions, alternatives and surfactant flow modifiers for slurries. (1974 - 1984)

- Chief Chemist/Department Manager - Schlegel Illinois Inc., Chicago, IL. Responsible for process engineering and compound formulating for extrusion and molding in a manufacturing facility for rubber seals. Had production responsibility for the molding department with 45 employees. (1972 - 1974)

- Rubber Chemist/General Foreman - General Tire and Rubber Co., Casablanca, Morocco. Responsible for quality control of raw materials and semi-finished compounds used to manufacture tires. Supervised three shift foremen of a plant department with 25 employees. (1970 - 1972)

AFFILIATIONS

- Member of AIChE.

PUBLICATIONS

Author of several publications including six patents.

CER 007552

RESEARCH

PROFESSIONAL PROFILE

TONY QUINTIN HAMMOCK
CHEMICAL ENGINEER, CHEMICAL PROCESS DEVELOPMENT,
CHEMICAL WASTE MANAGEMENT, INC.

EDUCATION

- B.S. Chemical Engineering, Texas A&M University, College Station, TX, 1986

CURRENT PROFESSIONAL HIGHLIGHTS

Mr. Hammock is a Chemical Engineer in the Chemical Process Development Department of R&D. Since October, 1986, he has worked on stabilization of hazardous wastes.

EXPERIENCE

Professional Experience: 4 yrs. Waste or Environmental Fields: 4 yrs.

- DOW Chemical, Freeport, TX. Co-op Assignment. Plant start-up and start-up problem solving. Also, computer process interfacing (data collection). (1/1985 - 5/1985)
- Dow Chemical, Freeport, TX. Co-op Assignment. Engineering projects involving repiping and installations of level devices. (5/1984 - 8/1984)
- Dow Chemical, Freeport, TX. Co-op Assignment. Worked in on-line Analyzer group. Repair and maintenance of on-line analytical equipment. (8/1983 - 1/1984)

CER 007553

SECTION 3.0

CER 007554

3.0 TYPICAL PUBLISHED REPORTS

CWM-ENRAC has provided two sample reports, one of which deals with stabilization of organic-contaminated soil, the other with basic filtration of sludge.

IMMOBILIZATION OF LOW LEVEL ORGANIC COMPOUNDS IN CONTAMINATED SOIL

Paul R. Lear
and
Jesse R. Conner

Chemical Waste Management, Inc.
Geneva Research Center
1950 South Batavia Avenue
Geneva, IL 60134

CER 007556

<u>Introduction</u> Stabilization or chemical fixation comprises the treating of materials contaminated with hazardous constituents in order to reduce or minimize the leachability of those constituents. Most stabilization systems in use today are inorganic, cementitious matrices. For hazardous metals, stabilization often involves the precipitation or reprecipitation of soluble metal species as less soluble species, as hydroxides or sulfides. The immobilization of the hazardous metals in less soluble species slows the potential release of the hazardous constituent into the environment and lessens the material's impact on the environment.

For organic-contaminated wastes, reactions which alter the organic compound or physical processes such as adsorption and encapsulation are used to retard the movement of the hazardous constituents. The distinction between these two classificationS is not clear-cut. Investigators are finding that immobilization assumed to be due to adsorption now appears to involve some sort of chemical bonding or even conversation of the constituent into another compound. The number of chemical reactions which might occur in hazardous waste is almost infinite. In practice, inorganic stabilization systems operating at ambient temperatures and pressures in non-exotic aqueous environments can produce only a relatively few reaction schemes: hydrolysis, oxidation, reduction and compound formation.

Hydrolysis. Hydrolysis refers to the reaction of a compound with water. This usually results in the exchange of a hydroxyl group (-OH) for another functional group at the reaction center. Hydrolysis may be catalyzed by acidic or basic species (H^+, OH^-, or H_3O^+) and many involve intermediates (*1*). Metal ions such as copper and calcium may act as catalysts for certain chemical structures, and adsorption on surfaces such as clay and activated carbon may accelerate reactions. Many organic compounds are resistant to hydrolysis, including some esters, many amides, all nitriles, and some carbamates and alkyl halides. Those less resistant to hydrolysis include alkyl and benzyl halides, polymethanes, substituted epoxides, aliphatic acid esters, chlorinated acetamides, and some phosphoric acid compounds.

Oxidation. Oxidation and hydrolysis are the most common pathways for the reaction of organics in stabilization systemS. Oxidation of organics occurs via two pathways (*2*). In one, an electrophilic agent attacks an organic molecule and removes an electron pair; in the other, only one electron is removed, forming a free radical. The former is heterolytic, the latter, homophilic. Free radial formation reactions have lowER energy barriers than the oxidation of a polar compound or cleavage of a covalent bond. Organic oxidation reactions in the chemical industries are typically catalyzed by crystalline aluminosilicates at elevated temperatures and pressures. Recently, it has been recognized that this also occurs at ambient temperatures with clay and soils, not only in oxidation, but in reduction, hydrolysis, and neutralization reactions (*1*). Iron, aluminum and trace metals within the layered silicate minerals have been identified as specific catalysts, though not all clays exhibit this property. Based on work by Dragun and Heller (*2*), two generalities can be made concerning the oxidation of organics by soils and clay minerals:

1) Many substituted aromatics undergo free-radical oxidation, e.g., benzene, benzidine, ethyl benzene, naphthalene, phenol;

that many instances of strong "sorption" at these surfaces may really be the result of exchange reactions such as are known to occur during the production of organo-clays from clay minerals by treatment with organic cations of the form $[(CH_3)NR]^+$.

Physical Process - Sorption and Encapsulation. Work on "physical" immobilization of organics has been primarily focused around several materials and mechanisms. Cote' (*5*) has shown that a variety of organics can be sorbed fairly effectively in cement-based stabilization processes incorporating activated carbon and bentonite additives; flyash and soluble silicates are less effective. Other conclusions from this work were:

- Volatile organics were not well immobilized
- Water soluble contaminants were not well immobilized
- Organics with low water solubility were well immobilized.

Kyle et al (*6*) compared a number of lime, kiln dust and flyash mixtures with organic reagent (vinyl ester, acrylic, epoxy, polymer cement) on several industrial wastes spiked with various priority pollutant organics. They found that the organic reagents produced poorer results, as measured by total organic carbon (TOC) in the leachate, than did the inorganic reagents. the addition of activated carbon to lime/flyash systems lower TOC leachability. Christenson and Wakamiya (*7*) found that Kepone leaching was increased in highly alkaline systems such as cement/soluble silicate, but decreased by encapsulation in either an organic polymer or a proprietary molten sulfur blend. Co-precipitation in ferric hydroxide precipitation systems was found to remove chlorendic acid, humic acid, PCBHs and other compounds from landfill leachate (*8*).

Experimental Procedures. Uncontaminated soil was obtained from the surface horizon of a fine-silty, mixed, mesic Mollic Hapludalf (Batavia silt loam, 2 to 5 percent slope). For the lower organic level experiments, two 4 kg portions of the clean soil were spiked with approximately 50 organic compounds (Table 1) and mixed in a sealed mixer. Sufficient spiking material was applied so that the spiked soil contained approximately 100 ppm of each constituent after mixing. Actual levels varied between about 5 and 2400 mg/kg as measured in the TCA analysis. Total organic level in the soil was between 0.5 and 1.0%.

For the higher organic level experiments, two 4 kg portions of the clean soil were spiked with 10 organic compounds and mixed in a sealed mixer. Sufficient spiking material was applied so that the spiked soil contained approximately 1000 ppm of each constituent after mixing. Actual levels varied between about 100 and 12000 mg/kg as measured in the TCA analysis. Total organic level in the soil was approximately 6.0%.

A combination of cement and one of 11 different admixtures were mixed with portions of the spiked soil. The admixtures selected were those commonly employed for the stabilization of organics or have been proposed for that use. A portion of one of the spiked soils was mixed with Portland cement alone to determine the efficacy of the admixtures. All formulations contained Portland cement at 20% by weight (expressed as weight of reagent to weight of raw, wet waste). The addition of admixtures was at 10% by weight. The spiked soil samples and the stabilization treatment residues were completely characterized by both TCA and TCLP. TCA and TCLP comparisons were made between the spiked soil and the stabilized residues derived from its treatment.

The study was conducted following the guideline established in the "Quality Assurance Project Plan for Characterization Sampling and Treatment Tests Conducted for the Contaminated Soil and Debris (CS&D) Program" (9), detailing the requirements for all sampling and analysis efforts. Trip equipment and field blanks were taken during the study. Sample custody forms established the chain of custody record for each sample. The analytical methodology used was from Test Methods for Evaluating Solid Waste (SW-846), Third Edition (U.S.E.P.A., 1986). Internal Chemical Waste Management quality control and quality assurance protocols were followed during the analytical portion of the study.

Results and Discussion - Low Organic Level. Stabilization decreased leachable organic constituent levels in most cases, but the degree of success depended heavily on the formulation used. The TCLP results for this portion of the study are given in Tables 2 and 3. Again, the best way to evaluate the results with respect to the ability of stabilization to immobilize low-level organics is to look at the reduction factors rather than the absolute quantities. The reduction factors for TCLP levels are given in Tables 4 and 5 for organic constituents found in the TCLP extract of the spiked samples at levels above the quantification level (LOQ). The larger the TCLP reduction for a given constituent, the more effective the immobilization, though volatility should be consider for the volatile constituents. Admixtures A and J are the most effective for organic immobilization for both volatiles, semi-volatiles and pesticides. Admixture E is effective for volatiles (however, see comments below). Other admixtures seem effective for certain organic compounds or compound classes.

Certain constituents appear to be more difficult than others to immobilize. These include: acetone, 1,2-dichloroethane, ethyl benzene, tetrachloroethylene, n-butanol, methanol, and pyridine. Other constituents were immobilized by all formulations: carbon disulfide, ethyl acetate, methylene chloride, 1,1,2-trichloro-1,1,2-trifluoroethane, 1,2-dichlorobenzene, 1,4-dichlorobenzene, hexachlorobutadiene, and hexachloroethane. However, all constituents except pyridine could be treated to meet the TC requirements (Table 1).

The reduction factors for TCA levels are given in Tables 6 and 7. For most semi-volatile organic compounds, TCA reduction did not occur. The TCA reductions shown for semi-volatile compounds probably reflect changes in the extraction efficiency of the analytical methodology as effected by the formulation. However, destruction or change in the constituent may also have occurred. Admixture G and K appear effective at reducing the measurable levels of semi-volatile constituents, while the other formulations seem to reduce levels of only a select few semi-volatile constituents.

Table 3. TCLP Leachate Analysis for Admixtures E - K at Low Scaling Level

Sample Type	Soil	Sample	Sample	Sample	Sample	Sample	Sample	Sample
Admixture		E	F	G	H	I	J	K
Binder		Cement	Cement	Cement	Cement	Cement	Cement	Cement
Analysis by Compound	TCLP	TCLP	TCLP	TCLP	TCLP	TCLP	TCLP	TCLP
	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Acetone	60000	<500	18250	17250	20750	14750	20250	8850
Benzene	4900	<250	8600	9950	7750	5300	<250	2250
2-Butanone	64000	<500	17000	17200	18000	13250	13200	9800
Carbon Disulfide	8200	<250	<250	<250	<250	<250	<250	<250
Carbon Tetrachloride	32000	<250	7000	8200	4300	3250	300	900
Chlorobenzene	<250	5800	30250	20800	12700	<250	<250	8700
Chloroform	<250	<250	6000	11000	8200	5300	1100	1450
1,2-Dichloroethane	6650	<250	13000	21000	20000	10800	3400	6300
1,1-Dichloroethylene	<250	<250	<250	250	<250	<250	<250	<250
Ethyl Acetate	11800	<250	<250	<250	<250	<250	<250	<250
Ethyl Benzene	10000	3000	17000	9250	6300	7000	1250	2000
Ethyl Ether	27250	<800	1450	1000	800	<800	<800	<800
Methylene Chloride	12000	<250	500	<250	800	<250	400	<250
4-Methyl-2-Pentanone	77000	<500	30000	30000	40000	20000	3000	28250
Tetrachloroethylene	24000	1200	18750	8700	5800	8700	<250	2250
Toluene	32300	1400	16200	13700	6000	8250	<250	4450
1,1,1-Trichloroethane	13300	<250	<250	<250	2000	<250	<250	<250
Trichloroethylene	40000	<250	10700	12700	8400	7000	<250	2400
Trichlorofluoromethane	300	<250	<250	<250	<250	<250	<250	<250
1,1,2-Trichloro-1,2,2-Trifluoroethane	3000	<250	<250	<250	<250	<250	<250	<250
Total Xylenes	11000	2000	14200	7400	4200	6100	<250	2300
N-Butanol	43700	<5000	31400	31450	61200	30100	11000	25700
Cyclohexanone	11100	<5000	7100	6700	8300	<5000	<5000	5200
Iso-Butyl Alcohol	47700	<5000	32000	28400	66000	20000	30500	20050
Methanol	300000	14400	118100	100842	120000	77000	74673	64000
Anthracene	<20	<20	220	<20	<20	<20	<20	<20
Bis(2-Ethylhexyl) Phthalate	<20	<20	220	<20	<20	22	<20	<20
1,2-Dichlorobenzene	1900	630	3100	714	400	490	<20	526
1,4-Dichlorobenzene	1400	281	2410	400	323	677	<20	363
2,4-Dinitrotoluene	4400	1000	4370	7000	2810	474	<20	9830
Hexachlorobenzene	<20	<20	180	<20	<20	<20	<20	<20
Hexachlorobutadiene	137	188	236	<20	38	44	<20	<20
Hexachloroethane	378	172	800	84	102	128	38	80
2-Methylphenol	<100	<100	<100	<100	<100	<100	<100	<100
4-Methylphenol	11000	<100	14200	11000	14000	4000	<100	11000
Naphthalene	2000	1400	2810	745	510	400	140	784
Nitrobenzene	6650	2000	6730	4000	3510	4630	<20	4000
Pentachlorophenol	2300	700	14200	6000	12200	<200	<200	4000
Pyridine	30000	5320	24000	41100	33000	32200	25300	34700
2,4,5-Trichlorophenol	8100	140	10200	<800	18000	<800	220	11000
2,4,6-Trichlorophenol	12700	<100	10000	<100	17200	<100	1100	12100
Phthalic Anhydride (As Acid)	<1000	1510	<100	<1000	<1000	<1000	<1000	<1000
1-Naphthylamine	<20	<20	17000	10000	8820	820	<20	11000
gamma-BHC (Lindane)	<200	400	340	<200	<200	<200	<200	<200
Methoxychlor	<200	<200	<200	<200	<200	<200	<200	<200
2,4-D	<1000	<8000	<8000	<8000	33000	<8000	<8000	<1000
2,4,5-TP (Silvex)	<100	<800	<800	<800	20000	<800	<800	<100

Table 6. TCLP Reduction for Admixtures E - K at Low Dosing Level

Sample Type Admixture Binder Analysis by Compound	Sample E Cement TCLP Reduction	Sample F Cement TCLP Reduction	Sample G Cement TCLP Reduction	Sample H Cement TCLP Reduction	Sample I Cement TCLP Reduction	Sample J Cement TCLP Reduction	Sample K Cement TCLP Reduction
Acetone	>120	4	4	2	4	3	7
Benzene	>20	NR	NR	NR	NR	>20	2
2-Butanone	>120	4	4	3	6	5	7
Carbon Disulfide	>33	>33	>33	>33	>33	>33	>33
Carbon Tetrachloride	>120	4	4	7	10	107	63
1,2-Dichloroethane	>20	NR	NR	NR	NR	NSR	NSR
Ethyl Acetate	>40	>40	>40	>40	>40	>40	>40
Ethyl Benzene	5	NR	NSR	3	2	13	6
Ethyl Ether	>66	18	14	30	>66	>66	>66
Methylene Chloride	>40	24	>40	18	>40	27	>40
4-Methyl-2-Pentanone	>104	3	3	NSR	3	21	3
Tetrachloroethylene	30	NSR	2	4	2	>90	11
Toluene	22 -	2	2	4	3	>120	7
1,1,1-Trichloroethane	>63	>63	>63	8	>63	>63	>63
Trichloroethylene	>100	4	3	6	6	>100	17
1,1,2-Trichloro-1,2,2-Trifluoroethane	>12	>12	>12	>12	>12	>12	>12
Total Xylenes	4	NR	NSR	3	NSR	>40	6
N-Butanol	>8	NSR	NSR	NR	NSR	4	NSR
Cyclohexanone	>2	NSR	NSR	NSR	>2	>2	2
Iso-Butyl Alcohol	>10	NSR	NSR	NR	NSR	NSR	NSR
Methanol	10	2	3	2	3	4	4
1,2-Dichlorobenzene	3	NR	3	4	4	>90	4
1,4-Dichlorobenzene	5	NR	3	4	3	>73	5
2,4-Dinitrotoluene	3	NSR	NR	NSR	8	>224	NR
Hexachlorobutadiene	NR	NR	>7	7	3	>7	>7
Hexachloroethane	2	NR	4	4	3	13	6
4-Methylphenol	>110	NR	NR	NR	3	>110	NR
Naphthalene	NSR	NR	3	4	6	14	3
Nitrobenzene	2	NR	NSR	NSR	NSR	>30	NSR
Pentachlorophenol	3	NR	NR	NR	>12	>12	NR
Pyridine	8	NSR	NR	NR	NR	1	NR
2,4,5-Trichlorophenol	86	NR	>10	NR	>10	37	NR
2,4,6-Trichlorophenol	>137	NR	>137	NR	>137	12	NSR

NR = No reduction, constituent TCLP concentration for sample exceeded that in spike.
NSR = No significant reduction in constituent TCLP concentration as compared to spike.

CER 007561

Table 7. TCA Reduction for Admixtures E - K at Low Binder Level

Sample Type Admixture Binder Analysis by Compound	Sample E Cement Total Reduction	Sample F Cement Total Reduction	Sample G Cement Total Reduction	Sample H Cement Total Reduction	Sample I Cement Total Reduction	Sample J Cement Total Reduction	Sample K Cement Total Reduction
Acetone	2	NR		NR	>6	NR	3
Benzene	>6	7		>14	3	NR	4
2-Butanone	>8	NR	>2	NR	2	NR	3
Carbon Tetrachloride	>3	6		>8	2	NR	2
Chlorobenzene	>25	NR	NR	4	NR	NR	NR
Chloroform	>3	6		6	NR	NR	>3
1,2-Dichloroethane	>8	2	>2	3	2	NR	4
Ethyl Benzene	>20	>25	NR	6	NR	NR	NR
4-Methyl-2-Pentanone	>14	NR	NR	3	NR	>25	NR
Tetrachloroethylene	NR	NR	NR	4	NR	NR	NR
Toluene	>14	NR	NR	4	NR	NR	NR
1,1,1-Trichloroethane	>3	6		>7	2	NR	>3
Trichloroethylene	>6	2	NR	2	2	NR	2
Total Xylenes	>16	6	NR	5	NR	NR	NR
N-Butanol	>18	NR		5	>2	2	NR
Iso-Butyl Alcohol	>14	NR		2	>2	2	NR
Methanol	22	NR	2	3	NR	2	5
Anthracene	NR	NR	16	NR	NR	NR	8
Bis(2-Ethylhexyl) Phthalate		NR	>100	NR	NR		>100
1,2-Dichlorobenzene	NR	NR	17	NR	NR	NR	20
1,4-Dichlorobenzene		NR	17	NR	NR	NR	12
2,4-Dinitrotoluene	>2	NR	>103	NR	>10	>2	>103
Hexachlorobenzene	NR	NR	16	NR	NR	NR	8
Hexachlorobutadiene	NR	NR	21	NR	NR	NR	13
Hexachloroethane	NR	NR	13	NR	8	NR	6
4-Methylphenol		NR	>30	NR	>4	NR	5
Naphthalene	NR	NR	10	NR	NR	NR	12
Nitrobenzene	NR	NR	22	NR	NR	NR	17
Pentachlorophenol		>6	>60	>6	NR		>60
Pyridine	NR	NR	10	NR	NR	NR	12
2,4,5-Trichlorophenol		6	>20	>3	NR		>20
2,4,6-Trichlorophenol		>13	>120	>13	>13		>120
gamma-BHC (Lindane)	>16	>10	>10	2	>10	13	5
Methoxychlor	NR	NR	>8	NR	3	2	NR
2,4-D	>271	1101	1002	1002	2000	1227	1049

NR = No reduction, corrected total constituent level comparable to that in spike.

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Table 8. TCLP Leachate Analyses for Admixtures A - D at High Spiking Level

Sample Type / Admixture / Binder / Analysis by Compound	Spike TCLP (µg/kg)	Sample None Cement TCLP (µg/kg)	Sample A Cement TCLP (µg/kg)	Sample B Cement TCLP (µg/kg)	Sample C Cement TCLP (µg/kg)	Sample D Cement TCLP (µg/kg)
Acetone	460000	263000	140000	184000	210000	184000
Ethyl Acetate	533000	<12000	<5000	<500	<2500	<2000
Methylene Chloride	350000	84000	30400	56200	86300	12000
Tetrachloroethylene	120000	110000	17000	94700	130000	100000
Hexachlorobenzene	<1000	<1000	<1000	<1000	<1000	<1000
Naphthalene	9340	8200	<1000	2120	2210	6010
Nitrobenzene	180000	100000	18000	64400	81000	82400
Pyridine	901000	470000	711000	300000	157000	437000
2,4,5-Trichlorophenol	101000	73000	8000	27000	27000	102000
Methacrylonitrile	<10000	<10000	<10000	<10000	<10000	<10000

Table 9. TCLP Leachate Analyses for Admixtures E - K at High Spiking Level

Sample Type / Admixture / Binder / Analysis by Compound	Spike TCLP (µg/kg)	Sample E Cement TCLP (µg/kg)	Sample F Cement TCLP (µg/kg)	Sample G Cement TCLP (µg/kg)	Sample H Cement TCLP (µg/kg)	Sample I Cement TCLP (µg/kg)	Sample J Cement TCLP (µg/kg)	Sample K Cement TCLP (µg/kg)
Acetone	400000	30000	220000	220000	440000	340000	210000	170000
Ethyl Acetate	600000	<5000	<5000	<5000	<5000	<5000	<5000	<5000
Methylene Chloride	310000	<5000	25000	66000	70000	84000	44000	46000
Tetrachloroethylene	111000	13000	120000	77000	63000	60000	14000	20000
Hexachlorobenzene	<20	<20	<20	<20	<20	<20	<20	<20
Naphthalene	10000	8000	11700	8840	4000	1000	170	2070
Nitrobenzene	74000	40400	63000	85100	42200	18400	5840	40000
Pyridine	430000	217000	332000	320000	357000	184000	32000	400000
2,4,5-Trichlorophenol	64400	<5000	284000	184000	167000	140	31200	34100
Methacrylonitrile	<200	<200	<200	<200	<200	<200	<200	<200

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Table 12. TCA Reduction for Admixtures A - D at High Spiking Level

Sample Type Admixture Binder Analysis by Compound	Sample None Cement Total Reduction	Sample A Cement Total Reduction	Sample B Cement Total Reduction	Sample C Cement Total Reduction	Sample D Cement Total Reduction
Acetone	NR	NR	NR	NR	NR
Ethyl Acetate	> 300	> 1000	> 10000	> 1000	> 10000
Methylene Chloride	2	NR	2	NR	5
Tetrachloroethylene	NR	6	2	2	2
Hexachlorobenzene	NR	NR	NR	NR	30
Naphthalene	NR	NR	NR	NR	11
Nitrobenzene	NR	NR	NR	NR	10
Pyridine	NR	NR	NR	NR	7
2,4,6-Trichlorophenol	3	6	NR	10	77
Methapyrilene	NR	NR	NR	NR	NR

NR = No reduction, corrected total constituent level in sample comparable to that in spike.

Table 13. TCA Reduction for Admixtures E - K at High Spiking Level

Sample Type Admixture Binder Analysis by Compound	Sample E Cement Total Reduction	Sample F Cement Total Reduction	Sample G Cement Total Reduction	Sample H Cement Total Reduction	Sample I Cement Total Reduction	Sample J Cement Total Reduction	Sample K Cement Total Reduction
Acetone	30	2	NR	2	2	4	2
Ethyl Acetate	140	>100	>100	>100	>100	>225	>100
Methylene Chloride	>40	>40	8	17	2	>40	3
Tetrachloroethylene	31	5	NR	2	2	8	NR
Hexachlorobenzene	NR	NR	NR	NR	NR	NR	NR
Naphthalene	NR	NR	NR	NR	NR	NR	NR
Nitrobenzene	NR	NR	NR	NR	NR	NR	NR
Pyridine	3	NR	2	NR	NR	2	NR
2,4,6-Trichlorophenol	>3	3	4	3	2	4	NR
Methapyrilene	NR	NR	NR	NR	42		

NR = No reduction, corrected total constituent level in sample comparable to that in spike.

CER 007564

A SHORT DISCUSSION ON

BASIC FILTRATION OPERATION AND THEORY

Presented by:

James W. Schleiffarth, Director
CWM/Waste Separation Technologies

CER 007565

1. WHAT IS PRESSURE FILTRATION?

CER 007566

A. INTRODUCTION

Pressure filters are used for solid-liquid separation of sludge by the application of pressure on the solid-liquid mixture in order to squeeze out the liquid through a filter medium. The objectives of pressure filtration may be either:

1. To get a cake of higher solids content of 30 to 80% from slurries with a solids content ~ 5 to 40%, or

2. To obtain a very clear filtrate from a liquid containing very fine particles (≤ 0.05).

The filter medium, which retains the solids and passes the liquid through it, must withstand the stress and strain during the application of high pressure. It is generally made of a cloth of natural or synthetic fibers, coil springs, a wire mesh fabric, or sheets made of particulate or fibrous materials such as diatomite, asbestos, or glass fiber bonded together with epoxy resin for added strength.

B. PRINCIPLE AND THEORY

When pressure is applied to a slurry, the liquid flows out from the pores of the particles and through the filter medium, which acts as a support. Particles deposited on the filter medium increase the thickness of the cake. Some of the particles may even penetrate the medium, depending on the pore size of the medium. Retention of particles by the filter medium and the growth of cake thickness increases the medium resistance to the flow of liquid. If applied pressure is kept constant, then the feed flow rate will decrease. However, constant feed flow rate could be maintained by either increasing the pressure or by limiting the cake thickness on the filter medium.

The basic filtration equation, as derived from Darcy's Law, is as follows:

$$Q = \frac{\Delta P \cdot A}{r_{AV} \cdot \mu \cdot C\left(\frac{V}{A}\right) + \mu R_f}$$

where Q is the volumetric flow rate of the feed suspension; V is the total volume of filtrate passed through the filter in time t; A is the face area of the filter; Δp is the applied pressure drop across the cake and filter medium, which may vary with time; μ is the filtrate viscosity; R_f is the medium resistance r_{av} is the average specific resistance of sludge; and C is the feed concentration.

If no loss of volume in the cake is assumed,

$$Q = \frac{dV}{dt}$$

For higher feed concentrations, the volume of the feed slurry and the filtrate differ significantly. Therefore, a correction based on the effective concentration is necessary as follows:

$$C = \frac{1}{\frac{1}{C} - \frac{1}{ps} - \frac{(M-1)}{p}}$$

C. DIFFERENT TYPES

Pressure filters are classified in two groups, namely, batch and continuous pressure filters, based on their mode of operation. Even though the latter type of filters is desirable, they are not common in practice because of their complex nature and high cost. The advantages of batch pressure filters are

- Rapid filtration of fine particles, which would otherwise be at a low rate
- The compact nature of the filters, with a high filtering area per

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unit plant space occupied

- The flexibility of operation provided by them at a relatively low initial cost

The disadvantage with the batch pressure filter is its high operating costs, especially when manually operated.

The batch pressure filters are operated in step-wise sequence for each cycle as mentioned below:

- Forming the filter cake
- Removing unfiltered slurry
- Washing the filter cake
- Compressing the filter cake remove excess liquid
- Blowing air or gas through the cake to discharge excess liquid
- Discharging the cake

Batch pressure filters can be grouped into three different types:

1. Filter presses (e.g., plate and frame, recessed plate, and sheet filters)
2. Leaf, plate, candle (tubular) filters (e.g., shell and leaf filters)
3. Variable-volume filters (e.g., membrane filters)

Cartridge filters and strainers, too, are pressure filters, but they are usually used online to remove small amounts of solids from liquid streams.

a. **Plate and Frame presses and Recessed-Plate Presses**

Filter presses consist of plates and frames in alternate sequence and can move along a guide. Plates have corrugated surfaces over which a filter medium, normally a woven cloth, is placed. Slurry feed enters through ports, and liquid flows out through a filter medium. There are various physical combinations in feeding slurry, drain, and guide. Another variation is the recessed-plate filter press which does not have any frame; the plate itself is recessed to allow the formation of cake. The advantage of plate and frame filter presses is that cake thickness could be varied by additional frames, which is important when handling slurries having variable characteristics. Compatibility with mechanized discharge and minimized leakage problems are the only advantages of recessed plate filter presses.

2. PRECOAT FILTRATION

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A. INTRODUCTION

Two kinds of precoat aids are used commonly in precoat filtration, namely diatomaceous earth and perlite. Other products like cellulose, wood flour, fly ash, and active carbon, which are used occasionally, alone, or in mixture with diatomaceous earth and perlite, are not discussed in this section, which provides general guidelines for the use of precoat filtration in water and wastewater treatment.

B. THEORY OF FILTRATION

Precoat filtration is the process used in the removal of suspended solids from liquid by filtering it through a cake made of filter aids. It depends upon the flow of liquid through the cake and the factors influencing this rate of movement. Many theories have been developed on this subject, and most of them are based on the modified Darcy's equation:

$$Q = \frac{KA\Delta P}{\mu L}$$

Where Q = flow rate; A = area of the filter; L = cake thickness; ΔP = pressure drop across the cake; μ = viscosity of the liquid; and K = permeability. If all parameters are expressed in metric units, permeability will be in "Darcy units".

Most of the commercial literature gives the permeability value of different filter aids proposed to the end-users.

Applying dimensional analysis (mass, time, length) to Darcy's equation, one can see that the Darcy unit has the dimensions of (length). A filter aid will have a permeability value of 1 D when 1 mℓ of liquid (with a viscosity 1 cP) is filtered through a cake of 1-cm thickness through a filter surface area 1 cm^2, in 1 s and using a differential pressure of 1 atm.

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It is obvious that cake thickness is one of the most important parameters to be considered in Darcy's equation. Cake thickness is used to calculate the cake density: a product having a cake density of 0.300 kg/dm^3 will build up a cake 1 mm thick, when using 0.300 kg of filter aid per square meter of surface area. Cake thickness is an important property in precoat filtration.

C. PRECOAT FILTRATION

1. Pressure Filters

Pressure filtration using filter aids is a three-step operation, namely: precoating, body feed, and washing (Figure 1).

a. Precoating

A thin layer of filter aid is built up on the filter septum by recirculating a filter aid slurry. This slurry is composed of water and filter aids, but may also contain a cellulose fiber to give stability to the precoat cake (mainly when the septum is a wire mesh stainless steel cloth). The mixture continues to circulate until the liquid from the filter septum becomes clear. The most common filtration system using filter aids is the pressure system (Figure 2). This can be either a plate-and-frame, candle element, or a wire screen-type filter with either a cloth, wire mesh, or ceramic filter septum. Most pressure filtration systems use a precoat of filter aid to protect the septum and to facilitate cleaning when the filter cycle is completed. Thickness of the precoat varies, but it is usually in the range of 2 to 3 mm (1/16 to 1/8"), which normally requires 350 to 1050 g of dry powder per square meter of filter area (7.5 to 25 lb/100 ft^2, based upon the wet cake density of the filter aid).

Normally, a precoat cake of 2 mm thickness is enough to start the filtration process. An amount of 350 to 700 gm of filter aid per square meter of filter surface is used to prepare the precoat slurry. The concentration of filter aids in the precoat tank used to make the precoat slurry is about 6 to 15% (w/w).

The major advantages of using a precoat are the following: to protect the filter cloth, to give an immediate clarity when filtering, and to improve cake removal and cake washing.

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FIGURE 1.

Mock-up of Precoat, Body-feed, and Cake Washer

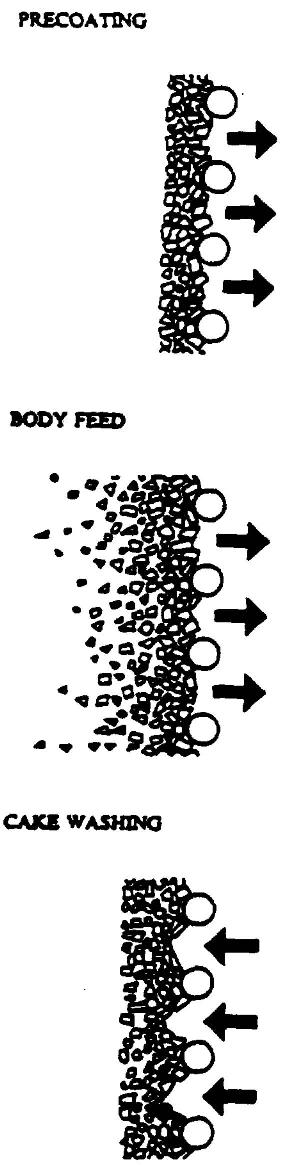

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FIGURE 2.

Effect of Body Feed Amount on Throughput

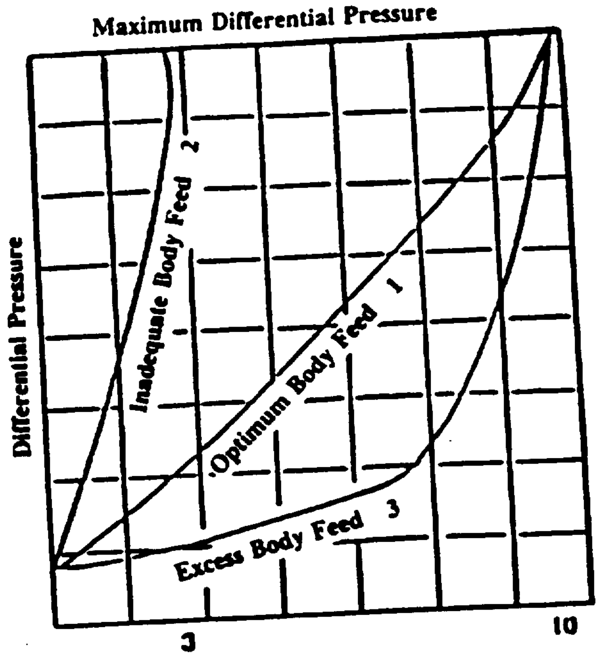
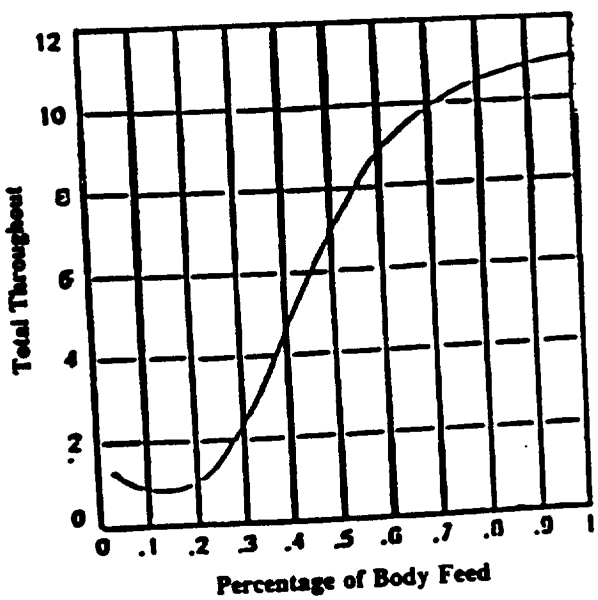


FIGURE 3. Cycle length (throughput at constant flow). (Courtesy of Manville de France, Paris.)



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As filtration proceeds, the volume of the cake increases until the solids trapped in the bed cause the flow to drop to an unacceptable level or the pressure to increase beyond the acceptable limit. Hence, it is very important to determine the optimum quantity of body feed to be used.

It is important to measure the differential pressure and flow rate during filtration.

b. Design Factors

1. Filtration rate: this is generally expressed in the units of L/h/m. The higher the flow rate, the more permeable should be the filter aid in order to obtain the desired clarity. This filtration rate is sometimes called surface loading rate. The higher the flow rate, the smaller should be the surface area of the filter. But higher filtration rates result in a rapid rise in pressure loss through the filter during the cycle. This results in shorter cycles with more frequent precoating. Hence, the choice of filter aid, in order to maintain desired clarity, is very important.

2. Body feed rate: this is defined as the amount of filter aid that must be added to each liter of raw water during filtration to ensure that the filter cake remains porous enough to facilitate the water flow. Prior to filtration, it is recommended that the following characteristics of the suspended solids be determined: percentage in weight, percentage in volume, particle size, mean diameter, shape, and nature (rigid, deformable).

   During the filtration operation, the limpidity of the water is, of course, a very important parameter and should be known. Clarification efficiency can be controlled by the following methods: conductometry, membrane filtration, and nephelometry, etc.

As a rule of thumb, one can establish the following: when the particle is rigid, the same amount of filter aid (in weight) as of suspended matter is added; whereas, when the particle is deformable, 10 times the amount filter aid (by weight) is added.

D. FILTER AIDS

1. Diatomaceous Earth

Diatomite is the skeletal remains of single-celled plants called diatoms. In life, these microscopic algae have the unique capability of extracting silica from water to produce their skeletal structure of frustule. When diatoms die, they settle to form a diatomite deposit. Although there are thousands of varieties of diatoms, not all of them are suitable for the production of filter aid.

Manville, the leading producer of diatomite, manages five deposits around the world with processing plants to produce the brand of filter aids called Celite. The most important Manville diatomite deposit is in Lompoc, California. Others are in Iceland, France, Spain, and Mexico.

Diatomite is processed by milling, calcining, and air classifying to give a finished, virtually inert filter aid which is predominantly silica.

There are three groups of diatomite filter aids. Table 1 presents their merits in water filtration. It is obvious that the final selection of the filter aids depends on the required effluent quality. Table 2 presents the physical properties of the principal Celite diatomite filter aids.

TABLE 1

RELATIVE MERITS OF DIFFERENT GROUPS OF DIATOMITE FILTER AIDS IN WATER FILTRATION

Type of Filter Aid	Clarification Efficiency	Flow Rate	Particle Size
Natural	Excellent	Poor	Very fine
Straight calcined	Good	Medium	Medium size
Flux calcined	Good to medium	High to very high	Medium to coarse

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TABLE 2

TYPICAL PHYSICAL PROPERTIES OF THE PRINCIPAL CELITE DIATOMITE FILTER AIDS

Grades	Filter Cel	505	577	Std. SuperCel	512	Hyflo SuperCel	501	503	535	545	560
Color	Grey	Pink	Pink	Pink	Pink	White	White	White	White	White	White
Fibra-Cel/Diatomite Blend Equivalent[a]	1	3	2	5	6	7	8	9	10	11	13
Approx. ΔP psi 1 gal/ft²/min with 0.15 lb/ft² precoat filter aid	3.2	2.0	1.2	0.7	0.4	0.1	0.07	0.06	0.03	0.02	0.005
Estimated gal/ft²/hr water 6 in. precoat 24 in Hg ΔP	b	b	b	10	20	50	65	130	240	370	1400
Water, permeability Darcies[c]	0.057		0.16	0.25	0.54	1.2	1.4	2.0	3.1	4.8	
Denisty kg/m³ dry	110	130	130	130	130	145	150	150	190	190	210
Density kg/m³ wet	260	370	290	290	300	290	290	290	300	300	320
% Retained 150 mesh screen	2	--	2	4	7	6	8	9	10	12	40
% Moisture as shipped	3.0	1.0	0.5	0.5	0.5	0.1	0.1	0.1	0.1	0.1	0.1
pH max	7.0	7.0	7.0	7.0	7.0	10.0	10.0	10.0	10.0	10.0	10.0
% Water solubles	0.15	0.15	0.10	0.10	0.10	0.15	0.15	0.15	0.15	0.15	0.15

Note: As expressed, these are typical or estimated physical properties, not specifications, and should be used accordingly.

a Fibra-Cel grades are designated by a number plus a letter (i.e., Fibra-Cel 7F). The number refers to the equivalent grade of Celite filter aid and the letter to the percent cellulose in multiples of 2-1/2%, i.e., A=2-1/2%, B=5%, C=7-1/2%, etc.

b Not applicable

c A material having a permeability of 1-D unit passes 1 ml/sec/cm² of a liquid of 1-CP viscosity through a cake of 1-cm thickness at a pressure differential of 1 atm.

2. Perlite Filter Aids

Perlite is a naturally occurring form of siliceous volcanic glass that is left behind after a period of volcanic activity of earth. Perlite ore can be found in deposits throughout the world. However, few ores were used to produce filter aids which satisfy the U.S. Food Chemical Codex. Perlite ore is composed principally of aluminum silicate, with a combined water content of approximately 3%.

To prepare filter aids, the perlite ore is expanded up to 20 times its original volume by heating. As the perlite expands and "pops", an infinite variety of tiny glass-like bubbles are produced, making the expanded perlite very light and possessing exceptional physical properties. Grinding of the expanded perlite, followed by an appropriate air selection, will give a complete range of perlite filter aids, as shown as Table 3.

E. APPLICATIONS

1. Water Filtration

The basic function of all water filters is to remove particulate matter from water. Precoat filters accomplish this by physically straining solids out of the water. There is no chemical reaction involved in this process. The grade of filter aid selected will offer the appropriate performance with respect to clarity and flow characteristics. Particles as small 0.2 μm can be removed by precoat filtration. This includes most surface water impurities. When a soluble contaminant is present, it must be precipitated prior to filtration; and, where colloidal matter or dispersed particles are present, precoat filtration alone may not be adequate to reduce the turbidity to the desired level. Flocculation with flocculants, prior to the filtration is necessary in this case.

TABLE 3

TYPICAL PHYSICAL PROPERTIES OF PERLITE FILTER AIDS

Property	Grade									
	J-206	J-208	J-4	J-1	J-2	J-10	J-100	J-150S	J-200S	J-250S
Color	White	White	White	White	White	White	White	White	White	White
Loose density dry (g/dm^3)	65	60	80	65	75	60	60	75	85	85
Wet density (g/dm^3)	240	160	200	140	175	150	150	150	150	150
% retained on 150 mesh	0.2	0.6	5.5	1	6.6	18	21	20	20	20
% H_2O as shipped	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
pH	6.5 - 7.5	6.5 - 7.5	6.5 - 7.5	6.5 - 7.5	6.5 - 7.5	6.5 - 7.5	6.5 - 7.5	6.5 - 7.5	6.5 - 7.5	6.5 - 7.5
Floater % volume	Tr	1	2.3	0.5	4	10	14	7.5	8	8.5
Permeability (D)	0.25	0.7	1.1	1.2	1.5	2.2	2.5	3.1	4.0	5.0

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3. CHEMICAL CONDITIONING

CER 007583

A. CHEMICAL CONDITIONING

Sludge is conditioned by biological, chemical, and/or physical treatment to enhance the dewatering characteristics of sludge. A variety of physical methods for altering sludge characteristics are available to facilitate the dewatering operation, like heating, freezing of sludge, use of admixtures, ultrasonic vibrations, and solvent extraction. All these can be used, although none of them are as yet in common use when compared with chemical conditioning. Particle size is considered to be an important parameter affecting the dewaterability of sludge. The primary objective of chemical conditioning is, therefore, to increase the particle size by adding chemicals which enable the particles to agglomerate into fewer large particles, or flocs. The formation of such flocs aids the dewatering process of the sludge. The common conditioning chemicals (or coagulants) for wastewater sludges are $FeCl_3$, $Fe_2(SO_4)_3$, alum, and lime. Before coagulants can combine with the solid fraction of the sludge, it must satisfy the coagulant demand of the liquid fraction. This is especially true when the alkalinity of the sludge is excessive. As a precipitant of bicarbonate (alkalinity), lime may be substituted for the portion of the coagulant that combines with the liquid fraction. It should be noted that lime forms only a precipitate with the fraction and does not form flocs.

Coagulant or conditioner requirements should first satisfy the liquid-fraction requirement approximated by the stoichiometry of the chemical reaction, i.e., for $FeCl_3$.

$$2FeCl_3+3Ca(HCO_3)_2-2fE(OH)_3(\downarrow)+3CaCL_2+6CO^2(\uparrow)$$

$$1 mg/l as CaCo_3 alkalinity requires (2\times162)/(3\times106)=1.08 mg/l of FeCl_3$$

CER 007584

The conditioner requirement should also satisfy the solid fraction requirement, which is a matter of experience.

It should be noted that the coagulant demand of the liquid fraction (or alkalinity) can be reduced either by lime addition (as a precipitant) or by washing out the alkalinity with water of low alkalinity. This process is called elutriation.

Commonly, $FeCl_3$ up to 2.5% of the weight of dry solids is used to condition raw or digested municipal sludges, but up to 7% is used for activated sludge. In addition, approximately 7 to 10% lime may be required. But, if the sludge is elutriated, the required $FeCl_3$ may be reduced by as much as 80% and lime addition may not be necessary. Table 3 gives the typical conditioner doses used for various sludges. While conditioning with $FeCl_3$ and lime is one of the most typical practices, the use of organic polymers or polyelectrolytes is gaining in popularity, although the use of $FeCl_3$ and lime will result in the production of drier cakes. There are instances where the total quantity of water present in both sludge solid cake and chemical solid cake produced from $FeCl_3$ and lime conditioning is greater than that produced from polymer conditioning.

B. APPLICATION OF FILTER AIDS

Many industries have adopted vacuum filtration process, using diatomite filter aids, in order to reduce the cost of filtered products. Diatoms consisting predominantly of silica which are insoluble in the process liquors form a strong filter cake/matrix, of great porosity that allows liquids to pass through at a fast rate, but which traps suspended solids on the outer surface, thus preventing cake penetration into the filtrates.

Hence, by the use of filter aids, very high flow rates or high dewatering rate can be obtained.

- REFINERIES/ TERMINALS/ PETRO-CHEMICAL PLANT

SLOP OIL EMULSION
API SEPARATOR BOTTOMS
DAF SLUDGE
RETENTION POND AND PIT SLUDGE
BIOLOGICAL SLUDGE
CRUDE TANK BOTTOMS
PRODUCT TANK BOTTOMS
CATALYST DECANT TANK BOTTOMS
CAUSTIC SOAP STOCKS
COOLING TOWER SLUDGE
SOUR WATER AND REACTIVE SLUDGE
DE-SULFURIZATION FROTH
OFF-SPEC PRODUCT
MISC. HAZ EMULSIONS
BENZENE, PHENOL; VCM CONTAMINATED SLUDGE

- PRODUCTION FIELDS

TANK BOTTOMS
DRILLING PIT SLUDGE
PRODUCTION PIT SLUDGE
EMULSIONS
ACID PITS

- WOOD TREATMENT PLANTS

TANK BOTTOMS
EMULSIONS
PITS/BASIN SLUDGE

- CARBON BLACK PLANTS

PICKLE LIQUORS
OILY EMULSIONS
TERMINAL TREATMENT SLUDGE
COOLING TOWER SLUDGE
BOF BLOW DOWN
MILL SCALE/OIL SLUDGE

- MISC. INDUSTRIAL PLANTS

WASTEWATER BIOLOGICAL SLUDGE
CLARIFIER UNDERFLOW SLUDGE
METAL HYDROXIDE SLUDGE
LIME/CA SULFATE SLUDGE
SMELTING/MINING SLUDGE

- FOOD INDUSTRY

DAF SLUDGES
CAUSTIC SOAP STOCKS (EDIBLE OIL REFINERIES)
BIOLOGICAL SLUDGES
GREASE TRAP WASTES

- POWER PLANTS

ASH AND LIME SLUDGE BASIN REMEDIATION
OILY SLUDGES
BOILER CLEAN OUT WASTE (ACID, METALS)

- SHIPYARDS

BILGE BOTTOMS
COLLECTIONS BASINS
DAF SLUDGE

- MUNICIPAL DISTRICTS

WATER TREATMENT LIME SLUDGE
SEWAGE SLUDGE
SEWAGE SCUM (GREASE EMULSION)

TREATABILITY TEST REPORT NO. 591

January 25, 1991

Chemical Waste Management, Inc.
Geneva Research Center
Waste Separation Laboratory
1950 S. Batavia Avenue
Geneva, IL 60134-3310
Telephone (708) 513-4500
Fax (708) 513-6401

CER 007587

Report No. 591,
Sludge Sample

FILTERABILTY TEST SYNOPSIS

The following test results were obtained using the sample received January 3, 1991:

Client:
Project Site:
Material: N/A
Sample Source: Tank
Quantity to be Processed: 3,000 BBl

SAMPLE CHARACTERISTICS	
Temperature	67 °F
Density	8.16 lb/gal
Solid Content (by Weight)	2.20%
Water Content (by Weight)	81.40%
Oil Content (by Weight)	16.40%
Sludge pH	N/A
Sludge Btu Value	3633 Btu/lb

Report No. 591,
Sludge Sample

FILTRATION CONDITIONS	
Filtration Unit	3" JWI
Filtration Area	40.54 cm^2 or 6.28 in^2
Filter Medium Type	Monofilamemt Multielement Polypropylene Twill, 70x20 Count, 5-8 CFW Rating
Medium Precoat (DE-FW-12)	0.05 lb/ft^2
Filtration Time	16 min
Filtration Pressure	30-100 psig *
Squeeze Time	20 min
Squeeze Pressure	160.00 psig
* The pressure was controlled at low levels at the beginning and gradually increased when the filtrate flow rate became low.	

FILTERABILITY TEST RESULTS

FILTRATE CHARACTERISTICS	With Squeeze	Without Squeeze
Oil Content (by Vol.)	9.47 %	6.67 %
Water Content (by Vol.)	90.53 %	93.33 %
pH	7.72	7.37
Filtrate Color	Tan	Tan
FILTER CAKE PROPERTIES		
Thickness	0.91"	1.34"
Density	77.04 lb/ft^3	69.33 lb/ft^3
Solid Content	39.17 %	29.45 %
Water Content	35.49 %	43.67 %
Oil Content	25.34 %	26.89 %
Cake BTU Value	5069 Btu/lb	N/A
Cake Ash Content	29.1 %	N/A

PRODUCTION ESTIMATION

Daily throughput rates are a direct function of the characteristics of the sludge to be processed and the dewatering equipment to be used. The production estimation made in this report is based on the experimental results obtained in the filterability test assuming a 92-cubic foot mobile system with membrane plates will be used. The 3" JWI filter press used in this work was originally designed by JWI, Inc. Further modifications were made in this laboratory so that the filtration mechanism and cake squeeze function of 92-cubic foot mobile systems are better simulated.

Since it is very difficult to obtain a representative sample from a sludge containment such as a tank or a lagoon. Predicted results should be considered as estimates only unless confirmed by multiple samples and field pilot test work.

Predicted Production Rates

1. Total Wt. of Dry Solid (TWDS)
   TWDS = Total Vol. Sludge x Sludge Density x Percent Sludge Solid

2. Total Wt. of Dry Solids in Filter Cakes (TWDSC)
   TWDSC = TWDS + Precoat Wt. + Total Additives

3. Total Wt. of Filter Cakes (TWFC)
   TWFC = TWDSC / Percent Cake Solid

4. Total Press Capacity Required (TPCR)
   TPCR = TWFC / Cake Density

5. Number of Cycles Needed (NCN)
   NCN = TPCR / Vol. of Press for Job

6. Cycle Time (CT)
   CT = Precoat Time (10 min) + Fill Time (10 min) + Filtration Time (as Determined from Test Result) + Squeeze Time (as Determined from Test Result) + Air Blow Time (5 min) + Cake Drop Time (30 min)

7. Number of Cycles per Day (NCD)
   NCD = 24 x 60 / CT x Efficiency Factor (0.8)

8. Number of Days Required (NDR)
   NCR = NCN / NCD

Report No. 591,
Sludge Sample

PREDICTED PRODUCTION SUMMARY		
Filter Press Capacity	92.00 ft^3	
Operating Temperature	Ambient	
Filtration Pressure	30-100 psig	
Filtration Time	16 min	
Squeeze Pressure	160.00 psig	
Squeeze Time	20 min	
Wt. of Sludge/Cycle	17.62 ton	
Volume of Sludge/Cycle	102.77 BBl	
	With Squeeze	Without Squeeze
Cycle Time	91 min	71 min
Number of Cycle/Day	12	15 *
Weight of Sludge/Day	211.46 ton	264.33 ton
Working Days Required	3	3
Cake Solid Content	39.17 %	29.45 %
Cake Water Content	35.49 %	43.67 %
Cake Oil Content	25.34 %	26.89 %
Cake Btu Value	5069 Btu/lb	N/A
Total Cake Volume	67.29 cu yard	99.48 cu yard
Total Cake Weight	69.99 ton	93.10 ton
Volume Reduction	89.21 %	84.06 %

* Although more cycles per day can be theoretically achieved, we do not recommend from a logistical standpoint that the project be bid over 15 cycles per day.

CER 007591

Report No. 591,
Sludge Sample

CONFIDENTIAL

SLUDGE PRETREATMENT	
Body Feed (Shredded Paper)	9.81 lb/BBl
Polymer (A.C. 1598C)	0.012 gal/BBl

ADDITIVES REQUIRED		
NAME	PER CYCLE	TOTAL
DE-FW-12 (Precoat)	83.34 lb	1.22 ton
Shredded Paper (Body Feed)	1007.97 lb	14.71 ton
A.C. 1598C % *	1.27 gal	36.99 gal

* A.C. 1598C is an cationic polymer manufactured by American Cyanamid. It should be diluted to 0.5% before being added into the sludge. To order the polymer, please contact:

Dan Robbins or Michael A. Walvoord
American Cyanamid
Specialty Polymers Department
2421 Production Drive, Suite 206
Indianapolis, Indiana 46241
1-800-426-5051
1-800-451-4111

CER 007592

Report No. 591,
Sludge Sample

Submitted by:

James W. Schleiffarth, Director 2/1/90
CWM Waste Separation Technologies
Date

Yisun Cheng, Project Engineer 1/28/91
CWM Waste Separation Technologies
Date

JWS/YSC/591.REP/ac
January 25, 1991

CER 007593

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SECTION 4.0

CER 007594

4.0 CWM-ENRAC QUALIFICATIONS

The following qualifications package highlights CWM-ENRAC services, including engineering, remedial construction, and off-site disposal.

CER 007595

CHEMICAL WASTE MANAGEMENT, INC.

ENRAC DIVISION

STATEMENT OF QUALIFICATIONS

CER 007596

1.0 INTRODUCTION AND EXECUTIVE SUMMARY

Chemical Waste Management, Inc. (CWM), through its Environmental Remedial Action Division (ENRAC), is pleased to present the following Statement of Qualifications for purposes of evaluation as it relates to providing remediation services.

Unlike many firms, CWM-ENRAC is able to provide a single source of responsibility for solving the remediation needs of a wide spectrum of hazardous waste sites. As a division of Chemical Waste Management, Inc., the nation's largest firm specializing in transportation, treatment, and disposal of hazardous waste, ENRAC is backed by the engineering, permitting, and operating infrastructure necessary to successfully accomplish the objectives of the remedial effort at CWM-ENRAC client sites. As one of the largest and most experienced remedial action firms in the country, CWM-ENRAC offers the full range of remedial options, ranging from on-site solutions such as solidification, thermal separation or incineration, to removal for off-site treatment and disposal.

Chemical Waste Management, Inc., a NYSE company, is the country's largest firm engaged solely in the hazardous waste industry with 1990 revenues of $1,146,972,000 and assets in excess of one billion dollars. In addition, CWM is one of the few companies in the industry that has been able to maintain environmental impairment liability insurance for our facilities as well as general and comprehensive liability insurance at levels well in excess of those generally provided by other industry participants. We believe that our demonstrated experience in all aspects of the hazardous waste industry coupled with our financial strength and our ability to secure and maintain high levels of insurance, provides CWM-ENRAC customers with the appropriate basis for assessing performance, risks and liability related to CWM-ENRAC's ability to successfully perform the required remediation at their facilities.

CWM-ENRAC's strength is augmented by the financial performance and stability of Waste Management, Inc., a publicly held, Fortune 500 company with 1990 revenues of $6,034,406,000 and assets in excess of $10.0 billion. While CWM is a publicly held NYSE company, Waste Management, Inc. retains 78% of the company's stock and the two corporations share common board members. Waste Management is the nation's largest corporation devoted exclusively to providing integrated solid, radioactive, and chemical waste management services.

In terms of project experience, CWM-ENRAC is uniquely qualified to serve the remedial marketplace, having performed over 3000 mitigation projects in total and over 300 mitigation projects of varying sizes and scope during calendar year 1990 alone. Many of these projects involved major remedial actions at multi-generator sites, as well as single client remedial programs.

Following, is CWM-ENRAC's Statement of Qualifications and experience.

CER 007597

2.0 CONTRACTOR'S QUALIFICATIONS

With the passage of the Resource Conservation and Recovery Act (RCRA) in 1976, Congress manifested the nation's heightened awareness and concern over the increasing problems associated with hazardous waste disposal. While the legislation was designed primarily to set standards for future management of hazardous wastes, there was grave concern over the practices of the past.

In 1978, in order to provide solutions to past disposal problems when they surfaced through discovery, violation, or pollution incidents, Chemical Waste Management, Inc. mobilized clean-up teams experienced in all phases of hazardous waste identification, analysis, handling, transportation, treatment, and disposal. Since there was no moving force or national governmental program at that time, our mobilization was accomplished on a regional and facility-specific basis, with clean-up response activities and capabilities being provided on a localized or regionalized basis. During this period of time, Chemical Waste Management, Inc. handled literally hundreds of clean-up projects varying in size from a few drums to several thousand tons of hazardous waste, responding to every type of hazard and/or problem imaginable and requiring the use of every bit of experience and discipline that CWM, or the industry, could provide. We continued to successfully perform in this fashion until early 1981 when Congress passed and implemented the "Superfund" legislation. It was at this time that Chemical Waste Management, Inc. formed the Environmental Remedial Action Division, appropriately called ENRAC.

Our purpose behind this was threefold: (1) to consolidate all of our past knowledge and experience into one organization that would specialize in the complicated and difficult field of site mitigation, (2) to provide CWM a single pool of people and resources that would be controlled and directed from one central management point, and (3) position CWM to be able to respond at the federal and state level nationwide with capabilities unmatched in the industry. This approach enabled CWM to continue to expand its knowledge and experience in the areas of hazardous waste site mitigation and remedial response.

2.1 CHEMICAL WASTE MANAGEMENT, INC. ENRAC DIVISION

Chemical Waste Management, Inc.'s Environmental Remedial Action Division (CWM-ENRAC) provides remedial action services at sites that are contaminated by hazardous or other regulated substances. In conjunction with other divisions of Chemical Waste Management, Inc., CWM-ENRAC is able to offer complete solutions to hazardous waste site problems, including the entire spectrum of tasks associated with the basic components of remedial activities investigation, design, and implementation.

SCOPE OF SERVICES

Although the process of site mitigation utilizes many task specific disciplines and various terminologies for the site mitigation process, it is the experience of CWM-ENRAC that all hazardous waste site mitigation projects can and should be broken down into three simple basic components:

- Investigation
- Design
- Implementation

These components represent the basic types of tasks which must be undertaken over the life of any project to:

- Define the nature and extent of the problem (Investigation);
- Determine the proper solution to the problem (Design); and
- Solve the problem (Implementation).

As the remedial action field has evolved, it has become clear that the most effective remedial actions are brought about through an integrated, multi-disciplinary approach to the basic project components of investigation, design, and construction. In the initial stages of the site mitigation industry in the United States, many firms and agencies procuring mitigation services elected to divide the management of the key project components, contracting them to separate entities. As a result of that non-integrated approach, in many cases the firm which was responsible for implementation of the selected solution encountered serious design flaws or data gaps in the work products of those responsible for design and investigation, often resulting in project delays and increased total cost. The occurrence of such situations has quite clearly demonstrated the need for an integrated approach to hazardous waste site mitigation projects. CWM-ENRAC is uniquely qualified to offer such an approach.

Chemical Waste Management, Inc. owns and operates the nation's largest network of hazardous waste treatment, storage, and disposal facilities, and, therefore, encounters on a regular basis the need for virtually the same types of activities as those associated with hazardous waste site mitigation. As a result, CWM has developed significant in-house capabilities for undertaking those tasks associated with investigation, design, and construction. We have augmented our in-house capabilities with those of outside firms on an as needed basis. Such outside firms would typically provide supplemental engineering and technical support with the vast majority of the actual mitigation work and related management functions being performed directly by CWM-ENRAC. Based upon a foundation of experience with selected design, engineering, and construction firms, CWM-ENRAC is able to assemble teams on a project-specific basis to provide the integrated approach for investigation, design, and construction for hazardous waste site mitigation.

Through the creation and management of these project teams, CWM-ENRAC can assure that all phases of the project activities are directed toward effective problem solving and the elimination of design flaws and data gaps when the project reaches the construction phase. CWM-ENRAC's management of all phases of the project assures the client of a focused, results-oriented effort aimed at an environmentally sound, cost effective solution to a client's environmental problems.

The scope of services which can be provided by CWM-ENRAC are described in the following sections - **INVESTIGATION, DESIGN, and IMPLEMENTATION.**

Chemical Waste Management, Inc., through its Environmental Remedial Action Division (ENRAC), has performed over three thousand remediation projects for private, industrial, and public sector clients since its founding in 1978. The majority of these remedial projects have required addressing key issues involved with remedial measures for soil, surface waste, and groundwater contamination. As a result of this experience, ENRAC has maintained a leadership position in the investigation, design and implementation of site remediations. Through a team approach, when such an approach is necessary, ENRAC has developed a comprehensive array of services ranging from site specific project tasks to complete design-build capabilities.

The investigation phase of a hazardous waste site remediation provides the critical baseline data necessary to design and implement a corrective remedial response. Specifically, investigation of a hazardous waste site provides detailed site characterization in terms of waste/contamination present, the magnitude and extent of contamination, rate and direction of waste migration, hydrology, site geology, and potential receptors (eco-systems, population at risk, etc.).

ENRAC has the available resources to develop a comprehensive site assessment program including:

- SITE CHARACTERIZATION
- SAMPLING/FIELD ACTIVITIES
- SITE INVENTORY
- GROUNDWATER STUDIES
- REGULATORY COMPLIANCE ASSESSMENT

SITE CHARACTERIZATION

Each site characterization is initiated by an extensive review of all available published literature archived in federal, state, or local sources. Detailed descriptions of the history, past activities, operations, and current site data are developed. Local interviews may be necessary to clarify past disposal or operational practices on-site. Regulatory agencies at all levels are contacted to review their files on compliance or enforcement issues.

In addition to the above, a review of all technical data is initiated. Information developed includes:

- <u>Topography</u> - surface physiography.
- <u>Structural Geology</u> - identification of regional/local joint and fault problems.
- <u>Stratigraphy</u> - identification and understanding of important stratigraphic units under the site.
- <u>Hydrogeology</u> - identification of drainage systems, flow characteristics, water quality of streams and other water bodies, which will aid in determining groundwater/surface water relationships at the site.

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FIELD ACTIVITY/SAMPLING

ENRAC has the experience and resources to develop and implement the field activities/sampling phase of a site investigation. Knowledge gained in the initial site characterization phase provides the baseline data necessary to produce a detailed field activities plan and sampling protocol.

Services and activities which can be provided by ENRAC are:

- Surface water sampling
- Surface sampling
- Waste sampling
- Sub-surface soil sampling
- Borehole geophysical logging
- Observation well installation
- Groundwater measurements and sampling
- Field chemical screening

Samples collected in the above activities are subject to a comprehensive QA/QC protocol. The overall objective of the QA program is to guarantee that all data will meet federal and state agency standards for precision and accuracy; that no contamination will be introduced by the sampling and analytical process; and to insure that a rigid chain of custody will be followed.

Analysis of the samples occurs at Chemical Waste Management, Inc.'s Technical Center in Riverdale, Illinois, or at one of the CWM regional laboratory centers. Field laboratory analysis is also available with one of ENRAC's mobile field laboratories. A comprehensive physical and chemical analysis is performed on each sample.

Types of analyses include:

- Physical chemistry
- Toxicity Characteristics
- Total metals
- Priority pollutants scan and analysis
- Pesticide screening
- PCB analysis

Overall field activities and sampling will serve to:

- Characterize waste contaminants.
- Determine the degree of contamination in the site soils and the mobility of the contaminants.
- Determine the degree and distribution of contaminant migration in the air, groundwater, and surface water associated with the site.

CER 007601

SITE INVENTORY

A critical portion of any site investigation is the completion of a site inventory. This inventory provides a overview of all surface wastes on-site and their aerial extent.

ENRAC has extensive experience in the conducting of site inventories on both major and minor hazardous waste sites throughout the country. Information developed through this inventory includes:

- Fugitive emission source
- Contaminated building locations and physical descriptions
- Waste source locations/quantities as:
  - Bulk waste
  - Containerized waste
- Drum inventory and analysis
- Surface water locations as:
  - Pits, ponds, lagoons

GROUNDWATER ASSESSMENT

Through Chemical Waste Management, Inc.'s corporate resources and team associates, ENRAC can perform detailed groundwater assessments on hazardous waste sites. CWM systems have available all current modeling programs and have CAD/CAM capabilities.

ENRAC and team associates have utilized a number of tested models and programs in predictive modeling activities.

A few of the services CWM-ENRAC can provide are:

- Groundwater quality sampling and assessment data base management;
- Detailed interpretation of groundwater chemistry in order to assess groundwater quality and groundwater contamination;
- Computer modeling of complex groundwater flow and contaminant transport;
- Simulation of remedial scenarios.

REGULATORY COMPLIANCE

After all phases of the site investigation are complete and the data is assimilated, CWM-ENRAC's environmental compliance personnel will conduct a regulatory compliance assessment. CWM-ENRAC personnel will determine, given site criteria, which remedial corrective measures are mandated or prohibited by regulation.

Completion of this assessment allows ENRAC to proceed with the design of corrective actions on a hazardous waste site.

DESIGN

The second phase of CWM-ENRAC's total remediation service to the client is the development of an environmentally sound and cost effective solution to the problem as defined by the results of investigative work. Ideally, this design phase matches the problem with currently available technologies. However, since regulations continue to evolve, currently accepted practices may not be acceptable at the time of implementation, creating the potential for confusion and delay that can be costly in terms of environmental impairment, corporate liability, and ultimate clean-up cost.

CWM-ENRAC understands this situation facing generators and fills the void of uncertainty by anticipating and planning for future technology and regulatory developments. By not limiting the focus of attention to present solutions, CWM-ENRAC provides innovative approaches to difficult remedial solutions. Through the financial, personnel, and material resources available within the Waste Management, Inc. network, CWM-ENRAC is researching and developing new technologies, improving and refining established methods, and assessing alternative and innovative processes for present and future client needs. As part of a CWM-ENRAC project approach, this technological problem solving capability is brought to bear on the defined problem through in-house remedial design and engineering, alternative technology assessment, specification preparation, and permitting. These resources are readily available to the client throughout the investigation, design, and implementation phases of a remedial action or at any single phase of the operation.

RESEARCH AND DEVELOPMENT

The effectiveness of remedial actions, as well as the efficiency with which they are conducted, depends on the ability of the contractor or project team to assess available data on the hazardous waste site and transform that information into a viable, implementable remedial action plan. Defining the contamination sources, transport pathways and potential health/environmental effects in terms of remedial solutions requires practical experience as well as a commitment to researching and developing new answers.

CWM supports ENRAC operations through the resources of the industry's largest hazardous waste analytical, research, and development facility at Riverdale, Illinois. The three building complex has over 40,000 square feet dedicated to providing analytical support to regional laboratories, duplicate analysis for quality assurance/quality control at the remedial site, assessment of alternative technologies for waste treatment and disposal, and research and development into new and innovative processes and technologies for future applications.

ALTERNATIVE TECHNOLOGY ASSESSMENT

During the design of a remedial solution, CWM-ENRAC undertakes a series of technology reviews to select the most feasible remedial activity.

The objective of this review is to assure that the ultimate design and implementation of remedies proposed have been assessed for the existing conditions at the site, the risks associated with those conditions, the possible reduction in risks afforded by implementation compared to the costs of implementation, and the reliability of designs compared to the magnitude of the remedial efforts.

PREPARATION OF REMEDIAL SPECIFICATION

Through the continued interaction of scientists, engineers, technicians and contractors, CWM-ENRAC can prepare all documents and specifications relating to the remedial design at the hazardous waste site. These capabilities include design of on-site disposal facilities, waste containment structures, waste storage and treatment facilities, groundwater clean-up plans/facilities, and other technologies specified during the alternative technology assessment for the individual site. In addition, where off-site treatment and/or disposal is the recommended solution, CWM-ENRAC will prepare a comprehensive materials handling and management system and specification which will include transportation and ultimate treatment and/or disposal.

IMPLEMENTATION

The third category of services provided by CWM-ENRAC is the implementation of the remedial action plan. Regardless of scale, CWM-ENRAC approaches each project with the same goal. That is to perform an environmentally sound solution, in the safest, most cost-effective manner.

This is accomplished through CWM-ENRAC's comprehensive project management approach. This approach is composed of four key elements including QA/QC, health and safety, CWM's environmental management department, and CWM-ENRAC's contract administration staff which are in addition to the operations management team assigned to implement the remediation effort. Through the use of this typical project organization, shown in the following Exhibit, these elements function in both line and oversight capacities to assure successful project completion. This project management system and our experience in implementing it has a proven track record of completion of projects on time and within budget.

QA/QC

The objective of quality assurance/quality control is to support remedial action assessments by establishing and maintaining project-wide procedures to ensure the scientific reliability, completeness, traceability, and comparability of all data and conclusions generated during a project. Overall conclusions are based on an understanding of the environmental situation at a site, which is derived from data collected during various task activities. The QA/QC objective, then, encompasses and integrates the various tasks of a project (geotechnical, sampling, analytical, testing, and assessment) by requiring data to be representative, precise, and accurate within defined limits. Documentation, prepared and maintained according to the QA/QC plan, provides the defensible evidence of unbroken custody, traceability, and adherence to prescribed protocols and planned operations.

HEALTH AND SAFETY

Chemical Waste Management, Inc.'s policy on this matter is based on the premise that, as a service oriented company, the firm's employees are its most important asset, and that their well-being is its greatest responsibility. Therefore, the health and safety of every CWM employee must be a primary consideration in every business decision and plan.

Accidents can be prevented and our excellent safety record is evidence of effective managerial performance. The objectives of the CWM health and safety program are both cost efficient and socially responsible. It is CWM's policy to do everything reasonable to protect its employees, property, customers, stock-holders and the public from the results of accidents. This necessarily includes providing a safe working environment and complying with accepted safe work practices and all health and safety regulations, codes and rules.

CWM effectively provides adequate training for everyone in its organization in order to help them to do their jobs safely and to teach them that they have a duty and responsibility to protect themselves, their fellow workers and the public. The ENRAC Division actively supports and participates in CWM's health and safety program and endorses the premise that "Accidents Can Be Prevented."

HEALTH AND SAFETY PERSONNEL

In line with its health and safety policy as stated above, CWM employs professionals who are educated and trained in occupational health and safety with respect to hazardous materials and their handling. Included in this group are Certified Industrial Hygienists (American Board of Industrial Hygiene), with others trained in CPR, first aid and various emergency and contingency procedures.

HEALTH AND SAFETY PROJECT PLANS

CWM-ENRAC follows rigorous health and safety protocols on all of its projects. Remedial operations are in strict accordance with OSHA, USEPA and/or US Army Corps of Engineers standards with a site-specific health and safety plan being required on each project prior to mobilization. As a minimum requirement, a site Safety Plan for the project will address the following issues:

- Identification of CWM-ENRAC personnel assigned to the project. Associated with this, a training program is presented prior to allowing these individuals to enter the project site. A medical surveillance program is initiated and the health and safety of project personnel are monitored throughout the remediation project.

- Preliminary investigation of the site is necessary to determine physical, chemical and biological properties of known contaminants. As a contingency measure, the Safety Plan also requires identification of off-site medical facilities to assist in emergency situations. As a contingency measure, personnel ingress and egress locations at the site are clearly identified and discussed with all project personnel.

- The Safety Plan (as well as the Site Contingency Plan) establishes work zones for the project site. These include an Exclusion Zone (i.e. "Hot Zone"), a Contamination Reduction Zone (i.e. "Buffer Zone"), and a Support Zone (i.e. "Clean Zone"). Individual areas within the Exclusion Zone may be delineated based on varying levels of suspected and/or demonstrated contamination which may require different levels of personal protection.

- Personnel and equipment decontamination procedures are established to minimize the potential of detrimental effects attributed to exposure by hazardous chemical vapors, liquids and/or contaminated solids. A decontamination facility is generally provided for personnel hygiene and safety control.

- Levels of personnel protection must be addressed as well as the establishment of specific air monitoring protocols. A determination is made regarding the applicability of either USEPA Levels A, B, C or D protection with specified personal protective equipment being provided. The air monitoring program is designed to detect and quantify ambient release and/or volatilization of soil contaminants or release of particulates associated with the remedial activities. Data from the air monitoring program is also used to determine appropriate levels of personnel protection during the site activities.

- Finally, emergency response (i.e. contingency) procedures are established prior to initiation of any CWM-ENRAC on-site operations.

ENVIRONMENTAL MANAGEMENT DEPARTMENT (EMD)

This department of CWM has the responsibility of assuring that all CWM activities, including any CWM-ENRAC projects, are operating within all regulatory guidelines and are in compliance. They function as internal auditors assuring the compliance with the governmental regulations, as well as the internal protocols and procedures.

CONTRACT ADMINISTRATION

The Contract Administration group is responsible for management of the contract function for the project, tracking the project activities from start to finish. The group monitors project scheduling, accounting, procurement and subcontracting. This function also assures that all work is done in accordance with contract specifications.

ANALYTICAL CAPABILITIES

To provide our clients with technically accurate site mitigations, CWM-ENRAC relies on sound chemical analytical practices. CWM-ENRAC owns and operates a fleet of mobile laboratories equipped to perform the classified wet analytical methods, as well as equipped with state of the art analytical instrumentation to perform more sophisticated testing. Depending on the analytical requirements of a project, these labs can be mobilized to the site. Once on-site they perform initial characterizations and greatly enhance sample turnaround times.

Supporting the field laboratories is the CWM Technical Center in Riverdale, Illinois. At this 40,000 square foot, three building complex is the largest privately owned laboratory devoted to chemical waste technology. The Technical Center staff chemists confirm the field laboratory's data, categorize and identify the waste streams, and determine the best methodology for managing them. In addition to the Technical Center, CWM operates laboratories at each of its treatment and disposal facilities.

A partial list of the type of laboratory equipment utilized includes:

- GC/Mass spec;
- IC plasma spec;
- Liquid chromatography;
- TOX (TOH) analyzer;
- Atomic adsorption;
- Gas chromatography;
- Infrared spectrophotometry

Each sample that is submitted for analysis at a CWM laboratory undergoes complete analysis according to EPA prescribed methods and can be completed routinely within two days.

ON-SITE OPERATIONS CAPABILITIES

CWM-ENRAC has the resources, experience, and the capability to manage the operations of any remedial action project relating to hazardous chemical waste. CWM-ENRAC can provide a single focal point of responsibility in site mitigation activity. The service capabilities we offer include:

CONSTRUCTION:

- Site preparation - including road improvements, staging pads, etc.

- RCRA storage cells.

- Site restoration - earthmoving to restore the topography, backfilling, and seeding.

- Process/system construction.

FACILITY DECOMMISSIONING:

- Building decontamination.
- Building demolition.
- Tank decontamination, removal, and demolition.
- Material excavation.
- Lagoon closures.

TYPICAL ON-SITE TREATMENT TECHNOLOGIES: (Not All Inclusive)

- Incineration.
- Activated carbon absorption.
- Air stripping.
- Solidification.
- De-watering.
- Containment - including capping and slurry wall construction.

Finally, in order to continue its leadership role, CWM-ENRAC maintains a substantial level of liability and hazard coverage related to its work. Certificates of Insurance evidencing such coverage for public liability and pollution risk under its Comprehensive General and Liability policy can be provided on request. CWM-ENRAC also maintains coverage for at least the amounts required under the financial responsibility regulation for non-sudden and accidental occurrences at its remedial project sites, as well as at its treatment, storage and disposal facilities. Certificates of Insurance for this latter coverage can be issued under CWM's Environmental Impairment Liability policy.

CORPORATE/PERSONNEL RESOURCES

CWM-ENRAC's ability to provide the full range of effective remedial action services is based upon a foundation anchored by three types of resources:

- The financial resources of Chemical Waste Management, Inc.
- The company's personnel.
- The company's experience.

FINANCIAL RESOURCES

Chemical Waste Management, Inc. is a New York Stock Exchange firm with approximately 78% ownership by Waste Management, Inc. the world's leading firm dedicated to the orderly collection, processing, and disposal of waste materials. Since its emergence, Chemical Waste Management, Inc. has grown to a leadership position within the industry from which it draws its name.

We have included a reference person to contact to verify our company's financial standing. For CWM financial information please contact: -

Commercial Information Services
c/o Continental Illinois National Bank
& Trust Company
231 South LaSalle St.
Chicago, IL 60697
(312) 828-2345

Chemical Waste Management, Inc.'s operating divisions serve commercial, industrial, and institutional customers.

As the availability of environmental impairment liability (EIL) insurance has markedly decreased, almost to the point of non-existence, the corporate resources of Chemical Waste Management have increased in importance. While CWM-ENRAC is one of the only firms that can still obtain true risk transfer EIL coverage, the majority of the company's liability coverage is on a dollar-for-dollar non-risk transfer basis. This being the case, the project activities of CWM-ENRAC are guaranteed not solely by our surety companies, but by the commitment of Chemical Waste Management, Inc.'s corporate resources. This corporate commitment necessitates our efforts to safeguard personnel safety and assure environmental compliance; our efforts to protect Chemical Waste Management, Inc.'s corporate resources while undertaking site mitigation projects provide our clients with further assurance that their needs will be addressed safely and professionally.

PERSONNEL RESOURCES

In addition to the financial resources of Chemical Waste Management, Inc., CWM-ENRAC has the ability to draw experienced, highly-qualified personnel from a pool consisting of not only those individuals assigned to CWM-ENRAC on a full-time basis, but also the entire spectrum of personnel from Chemical Waste Management, Inc. personnel nationwide.

When the need arises, this flexibility allows us to fully staff a project with professionals from a variety of disciplines, including chemistry, hydrogeology, engineering, operations management, health and safety, industrial hygiene, and regulatory compliance.

All personnel are trained, with regular updating, in health and safety protection procedures and are highly aware of CWM-ENRAC's commitment to personnel safety and regulatory compliance. CWM employs approximately 3,950 persons, of whom approximately 180 are employed as managers or executives, approximately 2,025 are employed in transportation, treatment, resource recovery, and disposal activities (including approximately 470 performing technical, analytical or engineering services), and approximately 750 are employed in sales, clerical, data processing, and other activities.

TREATMENT, STORAGE, AND DISPOSAL FACILITIES

In the event off-site treatment and disposal is an essential element of a site mitigation effort, CWM-ENRAC is uniquely qualified to provide such services.

CWM currently owns and operates 21 hazardous waste management facilities throughout the United States that offer transportation and/or waste transfer services, treatment and/or solvent recovery services, incineration services, secure land disposal services and specialized services dealing with PCB destruction or disposal. As technological advancements in managing hazardous wastes become viable, CWM facilities have consistently led the industry in bringing these techniques to the commercial market. These facilities' locations and capabilities are profiled in Exhibit I.

All of CWM's treatment, storage and disposal facilities maintain state-of-the-art technology and are fully-permitted by the USEPA and, where appropriate, by the respective state or local agencies. Among CWM's more noteworthy capabilities are:

- Incinerators in Chicago and Sauget, Illinois. The Chicago and Sauget incinerators are permitted to burn both liquid and solid hazardous wastes and the Chicago incinerator is also permitted to burn PCBs.
- TSCA-permitted secure chemical waste landfills in Alabama, California, New York and Oregon which can accept PCBs as well as hazardous wastes.
- RCRA-permitted secure chemical waste landfills in Illinois, Indiana and Louisiana which can accept hazardous wastes.
- Deep well injection systems in Ohio and Texas.
- Capacitor processing facilities in Alabama.
- Drum decanting systems in Alabama, California, Illinois, New York and Oregon.
- Transformer processing facilities in Alabama, California, New York and Oregon.
- Cyanide destruction capabilities in Alabama, California and New Jersey.
- Solvent recovery systems in Alabama, Ohio, Colorado and California.
- Sixteen transfer stations to facilitate the transport of hazardous wastes throughout the country.

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TRANSPORTATION CAPABILITIES

A fleet of more than 715 chemical waste collection and transportation vehicles supports CWM-ENRAC where transportation to an off-site facility is an essential part of the site mitigation plan. This fleet is the largest of its kind and includes such equipment as:

- DOT-coded bulk tankers (5,000 to 6,500 gallon capacity) including stainless steel, rubber-lined (both natural and butyl), steam jacketed and epoxy-lined.
- DOT-coded vacuum tankers (60 to 120 barrel capacity) including stainless steel, rubber-lined (both natural and butyl) and epoxy-lined.
- Forty foot enclosed van trailers.
- Forty foot flatbed trailers.
- Thirty foot dump trailers with water-tight discharge gates and sliding steel covers.
- Roll-off containers with water-tight discharge gates.
- Vac-All trucks for vacuum removal of solids and sludges.
- Specially-equipped railroad cars for hauling hazardous wastes; several cars are dedicated to PCB contaminated materials.
- An additional array of specially-equipped systems for wastes which preclude the utilization of conventional transportation equipment.

EXHIBIT I
CHEMICAL WASTE MANAGEMENT, INC.
Treatment, Storage, Disposal, Transfer, Transportation, and Response Facilities

MIDWEST REGION:

CID - Calumet City, Illinois	Chemical Waste Management, Inc.
	138th Street & I-94
USEPA ID NO. ILD010284248	Calumet City, Illinois 60409
Illinois EPA Site Nos.	312/646-3099
031600056	-
031600030	
Secure Chemical Landfill	Stabilization
Transfer Station	Regional Laboratory
Chicago, Illinois	CWM Chemical Services
	11700 S. Stoney Island Avenue
USEPA ID NO. ILD000672121	Chicago, Illinois 60617
ILLINOIS EPA SITE NOS.	312/646-5700
0316000058	
031600AGZ	
1984-EF-0579	
High Temperature Rotary Kiln Incineration	
PCB Incineration	Regional Laboratory
Drum Decanting/Repackaging	PCB Transformer Processing
Rail Car Off-Loading	PCB Capacitor Shredding
Sauget, Illinois	Trade Waste Incineration
	c/o Chemical Waste Management, Inc.
USEPA ID NO. ILD098642424	#7 Mobile Avenue
ILLINOIS EPA SITE NOS.	Sauget, Illinois 62201
16312109	618/271-2804
163121AAP	
1983-HB-1800	
Four (4) High Temperature	Laboratory Chemical Packaging
Incineration Units	Response Center
Repackaging Services	Transportation Services
Regional Laboratory	
Fort Wayne, Indiana	Adams Center Landfill
	4636 Adams Center Road
USEPA ID No. IND078911146	Fort Wayne, Indiana 46806
	219/447-5585
Secure Chemical Landfill	Regional Laboratory
Transportation Services	Drum Stabilization

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Alsip, Illinois

USEPA ID No. ILD00806604
IEPA Site No. 0310030005

Chemical Waste Management, Inc.
4300 West 123rd Street
Alsip, Illinois 60658
312/396-1920

Laboratory Chemical Packaging
Transportation Center

Newark, New Jersey

USEPA ID No. NJD089216790

Chemical Waste Management, Inc.
107 Albert Avenue
Newark, New Jersey07105
201/465-9100

Transportation Center	Regional Laboratory
Transfer Station	ENRAC Operations Center
Treatment/Recovery	Laboratory
Chemical Oxidation	Response Center
Fuels Blending	Chemical Precipitation
Neutralization	Organics Separation
Rail Car Off-Loading	Cyanide Destruction

Model City, New York

USEPA ID No. NYPD049836679

Chemical Waste Management, Inc.
P.O. Box 200
1135 Balmer Road
Model City, New York 14107
716/754-8231

Transportation Center	Stabilization
Transfer Station	Filtration
Treatment/Recovery	Secure Landfill
Chemical Oxidation	Regional Laboratory
Chemical Precipitation	PCB Services
Neutralization	Transformer Processing
Organics Separation	Response Center
Laboratory Chemical Packaging	Fuels Blending

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OLD - Vickery, Ohio

USEPA ID No. OHD020273819
Ohio EPA No. 03-72-0191

Chemical Waste Management, Inc.
3956 State Route 412
Vickery, Ohio 43464
419/547-7791

Acid Neutralization & Chemical Fixation
Chemical Precipitation
Deep Well Injection
Filtration
Organics Separation
Organics Separation
Transportation Services
Regional Laboratory
Oxidation Treatment (Planned)

Menomonee Falls, Wisconsin

USEPA ID No. WID003967148
Wisconsin DNR 10900

Controlled Waste Division
W124 N 94S1 Boundary Road
Menomonee Falls, Wisconsin 53501
414/255-6655

Drum Processing
Transportation Center
Waste Stabilization
Interim Drum Storage

West Carrollton, Ohio

USEPA ID No. OHD093945293

Solvent Resource Recovery (SRR)
4301 Infirmary Road
West Carrollton, Ohio 45449
513/859-6101

Solvent Recovery
Transportation Services
Fuels Blending
Regional Laboratory
Drum Decanting
Transfer Station

SOUTHERN REGION
Emelle, Alabama

USEPA ID No. ALD000622464
Ala. Dept. of Environmental Management No. 78-1

Chemical Waste Management, Inc.
Route 17 @ Milepost 137
Emelle, Alabama 35459
205/652-9721

Secure Chemical Landfill
Automated Drum Decanting/Deheading
Acid Neutralization & Chemical Fixation
Chemical Treatment & Detoxification
PCB Disposal
Regional Laboratory
Transformer Processing
Capacitor Processing
ENRAC Operations Center
Solvent Recovery
Stabilization
Transportation Center
Transfer Station

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Pompano Beach, Florida	Chemical Waste Management, Inc. 2700 Northwest 48th Street
USEPA ID No. FLD00776708	Pompano Beach, Florida 33067 305/973-6666
Transportation Services Transfer Station	ENRAC Response Center Laboratory Packaging
Lake Charles, Louisiana	Chemical Waste Management, Inc. Route 2
USEPA ID No. LAD000777201 Louisiana Dept. of Natural Affairs and Environmental Control Commission No. DT-507-P	Sulphur, Louisiana 70663 318/583-2169
Secure Chemical Landfill Drum Disposal Acid Neutralization Cyanide/Sulfide Treatment Fuels Blending	Regional Laboratory Drum Decanting Stabilization
Memphis, Tennessee	Chemical Waste Management, Inc. 2864 Business Park Drive Memphis, Tennessee 38118 901/362-7158
ENRAC Operations Center Transportation Center	Laboratory Chemical Packaging Response Center
Corpus Christi, Texas	Chemical Waste Management, Inc. 6901 Greenwood Road
USEPA ID No. TXD000761254 Texas Dept. of Water Quality No. 01337	Corpus Christi, Texas 78469 512/852-8284
Acid Neutralization & Chemical Fixation Chemical Oxidation Chemical Precipitation	Deep Well Injection Filtration Regional Laboratory

CER 007615

Port Arthur, Texas

USEPA ID No. TXD000838896

Chemical Waste Management, Inc.
Highway 73 (3.5 Mi. E. of Taylors Bayou
Port Arthur, Texas 77640

Texas Dept. of Water
Quality No. 39012-02

Acid Neutralization &
Chemical Fixation
Chemical Oxidation
Chemical Precipitation
Deep Well Injection
Drum Disposal
Filtration
Secure Chemical Landfill
Transportation Services
RCRA Incinerator

WESTERN REGION

Phoenix, Arizona

USEPA ID No. AZT050010180

Chemical Waste Management, Inc.
P.O. Box 6741
2301 West Broadway Road
Phoenix, Arizona 85005
602/243-6154

Transfer Station
Transportation Services

Kettleman Hills, California

USEPA ID No. CAT000646117

Chemical Waste Management, Inc.
P.O. Box 471
35251 Old Skyline Road
Kettleman City, California 93239
209/386-9711

Acid Neutralization &
Chemical Fixation
Chemical Oxidation
Chemical Precipitation
Cyanide Destruction
Drum Decanting & Disposal
Landfarming
Organics Separation
Secure Chemical Landfill
(TSCA Permitted)
Solar Evaporation
Transformer Processing
Transportation Services

CER 007616

Arlington, Oregon

USEPA ID No. ORD089452353
Oregon DEQ No. Hwy-1

Chem-Security Systems, Inc.
Star Route
Arlington, Oregon 97812

Acid Neutralization &
Chemical Fixation
Drum Decanting & Disposal
Filtration
Hydrolysis of Reactive Metals
Landfarming
Secure Chemical Landfill
(TSCA Permitted)
Solar Evaporation in Lined Ponds
Transformer Processing
Transportation Services

Hendersen, Colorado

USEPA ID NO. COD980591184

Oil and Solvent Process
Company, Inc. (OSCO)
P.O. Box 360
Commerce City, Colorado 80037
9131 East 96th Avenue
Hendersen, Colorado 80640

Solvent Recovery
Drum Decanting
Regional Laboratory
Transportation Center
Transfer Station
Drum Stabilization (Planned)
Fuels Blending

OSCO

USEPA ID No. CAD008302903

1704 West 1st Street
Azusa, California 91702

Solvent Recovery
Drum Decanting
Regional Laboratory
Transportation Center

Transfer Station
Rail Car Off-Loading
Fuels Blending
Drum Stabilization

CER 007617

3.0 PROJECT EXPERIENCE

3.1 CHEMICAL WASTE MANAGEMENT, INC. (CWM)

CWM-ENRAC is pleased to present the following record of remedial project experience for evaluation.

CWM owns and operates the largest hazardous waste transportation, treatment and disposal network in the United States. As such, our facilities have extensive experience with a wide range of waste materials both in terms of chemical composition and physical state. Materials handling capabilities vary at each location to best address specific waste streams and range from liquid handling capabilities, including drum decanting and bulk tankage, to sludge and solids handling.

Among large remediation projects, CWM was awarded a large privately funded remedial action project at an NPL site to date. The Phase II cleanup of the Western Processing facility in Kent, Washington, is valved at approximately $40 million. The scope of work includes excavation, transportation, and disposal of below surface material, design, construction, and operation of a groundwater pumping and treatment system, remediation of almost one mile of a creek, extensive groundwater remediation and related monitoring and testing.

This project involves significant engineering, design, construct, and permitting activities and, of the $40 million, 90% of the contract value involves on-site remediation efforts. In addition, CWM-ENRAC was awarded a $16 million contract by the Corps of Engineers to remediate an NPL site in Pennsylvania. The site, Lackawanna Refuse, involves installation of leachate collection and treatment systems, excavation and disposal of hazardous waste, full R.C.R.A. closure of three landfill cells, and construction of post closure monitoring facilities. As with the Western Processing project, the vast majority (75%) of the contract value is exclusive to on-site remediation efforts.

Throughout all the projects completed by CWM-ENRAC there exists a central commitment which is to provide our clients with a comprehensive and environmentally sound solution to their problems, in the safest, most cost-effective manner. Also, in the performance of remedial projects, Chemical Waste Management, Inc., and CWM-ENRAC accept commercial accounts and remedial projects under a professional code of conduct promoting confidentiality. The sensitivity of our projects arises out of the nature of problems with which we deal. The processing and disposal of hazardous substances and related corrective actions sometimes meet with strong public opposition. As a result, the client may be undeservedly subjected to adverse publicity.

Our contractual obligations to our clients precludes us from supplying such data. If this issue remains a critical element in the evaluation of CWM-ENRAC's qualifications, we will endeavor to obtain approval to release such data from our clients. The following Project Profiles effectively demonstrate the wide range of CWM-ENRAC's remedial action project experience. In addition to these profiles, a listing of remedial projects with brief descriptions has also been included. As explained previously, we refrain from publishing a list of our client's names', however, where we have received disclosure approval, clients are identified. We believe that the following description of the projects performed (along with their locations) should provide a sufficient basis on which to judge our level of expertise in the cleanup and disposal of hazardous waste.

1. SED Sites, - Greensboro, North Carolina

SCOPE OF WORK

CWM's ENRAC Division was contracted by Clean Sites, Inc. to perform the remedial action of the abandoned SED Corporation PCB storage facilities in Greensboro, NC. The work included removal, transportation, processing, and incineration and disposal of over 5,000,000 lbs. of PCB contaminated oils, transformers and materials. The buildings themselves were then decontaminated.

OBJECTIVES ACHIEVED

Material processing is complete with all the PCB contaminated materials removed from the warehouses, processed and incinerated or disposed of as appropriate. The building decontamination is complete.

COST/SCHEDULE VARIANCE

The project was completed ahead of schedule and under budget.

2. Western Processing - Kent, Washington (Phase I)

SCOPE OF WORK

CWM's ENRAC Division was contracted by a group of 180 potentially responsible parties to complete one of the largest generator-funded hazardous waste cleanups to date. The surface remedial action included the removal of several buildings, large quantities of liquid and solid wastes, full and empty drums, numerous bulk storage tanks and various pieces of process equipment. ENRAC's tasks included site preparation, including bridge improvements to facilitate the increase in truck traffic, transporting and establishing ENRAC's mobile lab, offices, decontamination trailer; building of a drum crushing area, establishing and maintaining an air monitoring program, and the sampling and analysis of all wastes for transportation and disposal which was also performed by CWM-ENRAC. In addition, a storm/surface water management system was employed which involved installation and operation by CWM-ENRAC of a mobile wastewater treatment system and obtaining of necessary permits. This treatment system is still being operated by CWM-ENRAC under contract to the PRPs.

CER 007619

OBJECTIVES ACHIEVED

The demolition of ten on-site buildings including transformers and associated substation equipment, the dismantling of 75 on-site bulk storage tanks, three railroad hopper cars and various processing vats. ENRAC removed 500,000 gallons of hazardous liquid waste, and 1,984 loads of contaminated solids. All the on-site debris including the tanks and hazardous wastes were then transported to approved CWM treatment and disposal facilities.

COST/SCHEDULE VARIANCE

The project was completed according to schedule and within the budgeted cost negotiated in the lump sum contract.

3. Enviro-Chem - Zionsville, Indiana

SCOPE OF WORK

U.S. EPA's Region V contracted with ENRAC to undertake an emergency action to temporarily stabilize the site while awaiting an anticipated settlement with the potentially responsible parties.

Following completion of the emergency action, CWM was selected by the generator group to perform and complete surface cleanup. Under terms of the consent decree, ENRAC's tasks included the analysis and identification of all remaining waste material in approximately 28,000 drums, tanks, and waste ponds; the removal, transportation, and disposal of those materials, assuring compliance with transportation, treatment, and disposal regulations of state and federal agencies; and the managing of storm water throughout the project duration to prevent the intrusion of off-site surface water runoff and divert on-site runoff to an existing cooling water pond on-site.

OBJECTIVES ACHIEVED

To complete the cleanup effort approximately 4,300 cubic yards of contaminated soil, approximately 28,000 drums of oil wastes and chlorinated materials, 300,000 gallons of liquids in 53 bulk tanks, and 1,500,000 gallons of ponded liquid were excavated, transported, and disposed of under EPA supervision.

COST/SCHEDULE VARIANCE

The surface cleanup work was completed within the eight month time frame specified in the consent decree, and within the costs negotiated in the lump sum contract.

4. Geneva Industries - Houston, Texas

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SCOPE OF WORK

CWM's ENRAC Division was contracted by U.S. EPA's Region VI to complete a planned removal of the Geneva Industries abandoned PCB's manufacturing site. The 13 acre site included several waste oil lagoons containing contaminated liquids and sludges (some sludges containing up to 44,000 ppm PCB's), a diked area surrounding two large bulk storage tanks, approximately 500 drums of various organic waste, and several landfill areas.

In addressing the treatment and disposal of the contaminated wastewater, a two cell modular adsorption treatment system was installed rather than removing, transporting, and treating the liquids off-site. The material discharged from the adsorption process was stored in 80,000 gallon on-site holding tanks, from which the purified water was transported via vacuum tankers to a nearby POTW.

OBJECTIVES ACHIEVED

The major tasks accomplished included: the removal, treatment and disposal of approximately 1.5 million gallons of contaminated water, excavation, stabilization, treatment and disposal of approximately 3,000 cubic yards of lagoon solids; and the removal and disposal of drummed waste. The excavated areas of the lagoons and ponds were lined, covered with sand, and backfilled with clay and sand. A top liner was then installed and capped with clay. Approximately 60,000 square feet of area were capped.

COST/SCHEDULE VARIANCE

The job was completed in a shorter time frame than initially estimated, and this is reflected in the final cost of the project.

5. Seymour Recycling Center - Seymour, Indiana

SCOPE OF WORK

Chemical Waste Management assumed responsibility for the complete surface cleanup of the abandoned Seymour Recycling Center in Seymour, Indiana, after working with the generator group from the inception of the project. The project included removal and disposal of waste contained in over 45,000 drums, 113 bulk tanks, and 15,000 cubic yards of contaminated soil.

Chemical Waste Management's technical personnel assessed and characterized the site, developed a scope of work necessary for a surface cleanup, prepared the technical proposal, and negotiated with U.S. EPA and the Indiana State Board of Health for acceptance of the proposal. With the acceptance of the technical proposal, CWM assisted the generator's legal group in the preparation of the consent decree that was approved by the Department of Justice and the U.S. District Court. ENRAC quickly mobilized and began the site preparation, including road construction, establishment of a drum crushing area, and placement of decontamination units, mobile laboratories, and office trailers. An on-going air monitoring program was established. Several on-site wells and underground piping running through the site were sealed. Complete chemical analysis was performed so that the bulking of compatible materials could be done prior to transportation and disposal.

OBJECTIVES ACHIEVED

All wastes, including 45,000 drums, tanks, debris, hazardous chemical waste, and approximately 15,000 cubic yards of soil, were transported to CWM facilities and disposed of in accordance with RCRA regulations. The excavated areas were completely restored with clean soil.

COST/SCHEDULE VARIANCE

The project was completed within the negotiated cost and schedule.

6. Pine Bluff Army Arsenal - Pine Bluff, Arkansas

SCOPE OF WORK

The ENRAC Division of Chemical Waste Management was contracted by the U.S. Army Corps of Engineers to remove, transport, and dispose of hazardous waste at the Pine Bluff Army Arsenal in Pine Bluff, Arkansas. ENRAC's tasks included: crushing and bulk shipping 8,000 empty drums; sampling and identifying the contents of approximately 3,000 55-gallon drums, and 15,000 5-gallon drums containing a variety of military chemical material; and the excavation, shipment and disposal of contaminated soil and scattered debris.

OBJECTIVES ACHIEVED

The successful removal, treatment, and disposal of all hazardous materials. This included all the drums, 4,500 gallons of liquid, and approximately 3,500 cubic yards of soil from the Pine Bluff Army Arsenal. These materials were bulked and shipped to CWM's Sulphur, Louisiana facility for secure disposal.

COST/SCHEDULE VARIANCE

The project was completed within the timeframe initially established, and below the estimated costs.

7. Rose Chemicals - Holden, Missouri

SCOPE OF WORK

CWM-ENRAC, under contract to Clean Sites, Inc., undertook remedial activities at the abandoned storage facility of Rose Chemicals located in Holden, Missouri. The tasks associated with this project were focused upon the stabilization of the site, which was totally uncontrolled prior to CWM-ENRAC's mobilization. These tasks included repackaging, spill assessment and containment, staging, and inventory of the entire contents of this facility.

OBJECTIVES ACHIEVED

CWM-ENRAC successfully characterized the site and inventoried over twenty million pounds of PCB contaminated oils, equipment, transformers, capacitors, and other debris. The inventory was developed with the use of a computerized bar code system which enabled CWM-ENRAC to produce a report detailing:

- The amount and type of material at the Rose Chemicals site by generation (if identifiable on that basis);
- The total amount of PCB liquids is 55-gallon drums, and their concentration;
- The amount of full capacitors, as a total, or in drums, or in crates;
- The total volume and concentration of PCB's in an individual tank, or a combination of tanks.

This information will be invaluable in preparing cost estimates for the follow-on phase at Rose Chemicals, and could be a valuable tool in developing a cost allocation model.

COST/SCHEDULE VARIANCE

The project was completed within the projected schedule and under the estimated budget for the project.

8. Western Processing - Kent, Washington (Phase II)

SCOPE OF WORK

The CWM-ENRAC Division was contracted by a Group of 180 Potentially Responsible Parties (PRP's) to continue the remediation of the Western Processing site. The work consists of the excavation, transportation, and disposal of subsurface material, the remediation of almost one mile of a creek and the related air and water monitoring that will be needed. CWM-ENRAC tasks included site preparation, including site improvements, to facilitate the increase in truck traffic, establishing and maintaining an air monitoring program and the sampling and analysis of all wastes for transportation and disposal which is being performed by CWM-ENRAC. In addition, CWM-ENRAC will be involved in the design, construction, and operation of a groundwater pumping and treatment system. This project will last approximately 10 years.

OBJECTIVES ACHIEVED

The majority of the subsurface excavation has been completed. CWM-ENRAC has removed over 10,000 yards of contaminated solids. All wastes were stabilized on-site prior to transportation and disposal at CWM treatment and disposal facilities.

COST/SCHEDULE VARIANCE

The project is on-going and is proceeding as scheduled and within the budgeted costs of the contract.

9. Lackawanna Refuse Site - Old Forge, Pennsylvania

SCOPE OF WORK

CWM-ENRAC was contracted by the U.S. Army Corps of Engineers to handle the remediation and treatment/disposal of contaminated materials form the abandoned 11-acre Lackawanna Refuse site. The project includes the removal and off-site incineration of up to 15,000 buried drums and the excavation and testing of more than 130,000 yd^3 of other buried waste, which will be transported off-site for disposal at one of CWM's secure chemical landfills. The project also involves construction and operation of an on-site treatment plant for leachate and contaminated water, complete closure of three disposal cells, and installation of a leachate collection, gas venting and groundwater monitoring systems.

A final phase of the project, scheduled for completion in the Spring of 1989 involves construction of a 1,300,000 square foot cap over the retrofitted landfill. This cap is comprised of a 6" select soil sub-grade, a 40 mil HDPE membrane, Tensar drainage net, a 6 oz. filter fabric followed by 18" of soil. On areas of slope more than 25 degrees, a layer of Geogrid will be placed over the 6 oz. filter fabric.

OBJECTIVES ACHIEVED

The landfill has been completely sorted through such that hazardous materials have been removed. The remaining non-hazardous materials will remain on-site in the new landfill.

COST/SCHEDULE VARIANCE

Project began September 1987 and was completed the Fall of 1989.

ADDITIONAL PROJECT LISTING

The following partial list of projects is representative of the commercial remedial action projects which Chemical Waste Management, Inc.'s ENRAC Division has completed.

PROJECT NAME & LOCATION	COST OF WORK (IN THOUSANDS)
Contaminated soil excavation - light construction. Ft. Worth, TX	1,000
Closure of PCB Oil Lagoon Davenport, IA	1,800
Clean-up of hazardous waste dumpsite Tacoma, WA	1,600
Lagoon closure Antioch, CA	1,400
Disposal Site Port Arthur, Texas	1,000
Clean-up of chlorinated organic waste disposal site Beaumont, Texas	1,000
Closure of Refinery Newark, New Jersey	6,300

PROJECT NAME & LOCATION	COST OF WORK (IN THOUSANDS)
Excavation of Abandoned Landfill Central, Illinois	20,000
Plant Decontamination Baltimore, MD	750
Excavation of PCB Soil Kingston, NY	2,000

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Remove and dispose of mercury contaminated soil Ponce, Puerto Rico	1,000
Clean-up of pesticide contaminated soil 3 sites, California	750
On-site drum repackaging site stabilization Arctic Circle, Alaska	700
PCB lagoon closure Albuquerque, NM	500
Closure of creosote lagoon Shreveport, LA	500
Clean-up and closure of hazardous waste lagoon Luling, LA	465

PROJECT NAME & LOCATION	COST OF WORK (IN THOUSANDS)
Clean-up of Drum Storage Site Seymour, Indiana	460
Landfill excavation Augusta, GA	450
Petroleum refinery lagoon closure Kansas City, Kansas	450
Contaminated Soil Removal Omaha, Nebraska	400
Clean-up of chemical waste dumpsite Houston, Texas	350
Clean-up of Chemical Waste Dumpsite Puerto Rico	300

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Clean-up of arsenic & pentachlorophenol soil Stockton, CA		300
Clean-up and demolition of chemical supply warehouse/fire Dallas, Texas		250

GOVERNMENT CONTRACTS

The following partial list of projects is representative of the governmental agency remedial actions which CWM-ENRAC has completed.

PROJECT NAME & LOCATION	AGENCY	COST OF WORK (IN THOUSANDS)
Federal (Non-DOD)		
Clean-up of drum storage site Texas City, TX	U.S. Coast Guard Houston, TX	52
Barker Chemical	USEPA Region VI	750
Site Closure Dallas, TX		
NIROP		
Drum Sampling, Analysis and Removal from Drum Burial Site Fridley, MN	U.S. Army C.O.E.	475
Excavate,Classify Segregate Drummed Material at Abandoned Drum Site Gary, IN	USEPA Region V	350
Classify, Segregated and Dispose of Material from Abandoned Drum Site KY	USEPA Region IV	80

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PROJECT NAME & LOCATION	AGENCY	COST OF WORK (IN THOUSANDS)
Classify, Segregate, Dispose of Drummed Material from Abandoned Drum Site Columbia, SC	USEPA Region IV	35
Emergency Response Pesticide Drum Cleanup Jacksonville, FL	USEPA Region IV	32
Emergency Response Athens, GA	USEPA Region IV	175
Department of Defense		
Collect & Dispose of DDT Waste at 79 Locations in 34 States	DRMS-Battle Creek, MI	1,800
DPDS Annual Contract Servicing, Packaging Transportation and Disposal Military Installations to Tennessee	DRMS-Battle Creek, MI	850
DLA200-83-C-0020 FL, SC, GA, NC	DRMS-Battle Creek, MI	50
DLA200-83-C-0019 PA, CT	DRMS-Battle Creek, MI	50
DLA200-83-C-0009 MD, VA, WV	DRMS-Battle Creek, MI	212

PROJECT NAME & LOCATION	AGENCY	COST OF WORK (IN THOUSANDS)
DLA200-83-D-0028 TN	DRMS-Battle Creek, MI	59
DLA200-84-R-0009 NJ	DRMS-BattleCreek, MI	949
DLA200-84-R-0010 OH	DRMS-Battle Creek, MI	145

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DLA200-85-B-0017 CT	DRMS-Battle Creek, MI	85
DLA200-85-B-0001	DRMS-Battle Creek, MI	152

State

Pollution Abatement Services

Plant Closure Oswego, NY	New York DEC Albany, NY	1,500
Clean-up of drum disposal site Hayward, CA	State Health Department State of California	350

Local

Annual contract Los Angeles Police Dept, Packaging, identify, transport and dispose -	LAPD	100

PROJECT NAME & LOCATION	AGENCY	COST OF WORK (IN THOUSANDS)
Illegal Drugs Los Angeles, CA		

Department of Defense

DLA200-84-B-0054 TX	DRMS-Battle Creek, MI	117
DLA200-85-B-0004 TN	DRMS-Battle Creek, MI	1,110
DLA200-85-R-0007 TX	DRMS-Battle Creek, MI	306
DLA200-84-B-0033 TX	DRMS-Battle Creek, MI	165
DLA200-84-B-0034 TX	DRMS-Battle Creek, MI	430
DLA200-84-B-0038 LA	DRMS-Battle Creek, MI	69

DLA200-83-B-0054 NY (SCA)	DRMS-Battle Creek, MI	218
DLA200-84-B-0018 MI	DRMS-Battle Creek, MI	79
DLA200-85-B-0006 CA	DRMS-Battle Creek, MI	2,468

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SECTION 5.0

CER 007631

5.0 HEALTH AND SAFETY PLAN

As requested by Monsanto, CWM-ENRAC has provided the following draft Health and Safety Plan for remedial site activities.

HEALTH AND SAFETY PLAN

CHEMICAL WASTE MANAGEMENT, INC.
ENVIRONMENTAL REMEDIAL ACTION DIVISION
MIDWEST REGION

CER 007633

1.0 PURPOSE AND SCOPE

This health and safety plan for environmental remedial activities is intended to prescribe minimum procedural and equipment requirements for worker protection. Operating conditions can be expected to change as the work progresses, requiring some modification of the plan. As appropriate, addenda will be provided by the ENRAC Site Safety Officer and/or the Health and Safety Manager.

The plan is designed to comply with established ENRAC policies and procedures, and applicable state and federal OSHA regulations. Therefore, no changes to the plan will be authorized without prior approval of the ENRAC Health and Safety Department. All ENRAC site personnel, site visitors, and subcontractor personnel are subject to the provisions of this directive.

2.0 KEY PERSONNEL AND RESPONSIBILITIES

Clear lines of authority shall be established for enforcing compliance with the health and safety procedures, consistent with industry policies and procedures.

Designated ENRAC personnel are responsible for field implementation of the health and safety plan. This includes field supervision, maintaining contamination control zones, enforcing safe work practices and decontamination procedures, ensuring proper use of personal protective equipment, and communicating modified safety requirements to site personnel.

The ENRAC Safety Officer is responsible for field technical coordination of the health and safety program. Specific site duties will include: establishing site work zones and decontamination stations; conducting periodic safety inspections; establishing emergency egress points, assembly areas, and first aid stations; implementing a site emergency warning/communication system(s); maintaining the local medical surveillance and emergency medical treatment programs; conducting site specific employee training and information sessions; conducting air monitoring; assigning appropriate personal protection levels for site personnel; auditing safety recordkeeping compliance; and service as technical liaison to regulatory agency personnel on matters related to occupational safety and health.

3.0 MEDICAL SURVEILLANCE

3.1 Examination Requirements

All site personnel, including subcontractors, shall successfully complete a medical examination within one year prior to their assignment to the project. The evaluation shall include, at a minimum:

3.1.1 A review of medical, personal, family and occupational histories.

3.1.2 Physical examination and clinical evaluation of the employee's ability to: Wear respiratory protective devices and protective apparel, to tolerate strenuous work and heat stress conditions, and to work with hazardous materials.

3.1.3 Clinical tests:

a. PA chest x-ray.
b. Pulmonary function (FEV 1.0) and (FVC).
c. Audiometry (approved booth).
d. CBC with differential, hematocrit.
e. Blood chemistry (SMAC 23 test survey).
f. Urinalysis (Including mercury).
g. Vision screening, and

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3.1.4 Any other tests deemed appropriate by the examining physician.

3.2 Emergency Medical Treatment

An Emergency medical treatment Plan is included in the site specific emergency contingency plan. The provisions for emergency medical treatment include:

3.2.1 Training in first aid and CPR for key project personnel.

3.2.2 Stocking appropriate first aid and CPR supplies and equipment.

3.2.3 Specific written medical emergency decontamination procedures, including written instructions for ambulance crews and hospital personnel as appropriate.

3.2.4 Conspicuously posted notices giving the names, phone numbers, addresses, and procedures for contacting the on-call physician, ambulance, medical facility, emergency fire and police services, and poison control hotlines.

3.2.5 Appropriate maps and directions to emergency medical facilities.

3.2.6 Periodic review of emergency medical treatment procedures with site personnel.

3.2.7 Prompt and accurate reporting of all accidents and incidents consistent with established procedures.

4.0 EMPLOYEE TRAINING AND INFORMATION

4.1 Initial Training

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4.1.1 All project employees must have completed an approved orientation and basic safety program before their assignment to the remedial project.

4.1.2 This coursework shall be a combination of formal classroom instruction, demonstration, and practical exercises in the following subject areas:

a. Hazard Awareness: describing the chemical, physical, biological and radiological hazards that may be encountered in the workplace.

b. Employee Rights and Responsibilities: describing corporate safety operating philosophy, employee information sources, and material safety data sheets.

c. Safe Work Practices: including the purpose for and application of work zones, contamination control and decontamination procedures.

d. Personal Protective Equipment: including instruction in the selection, use, maintenance, and limitations of the equipment; demonstration of proper use; and practice drills.

e. Emergency Preparedness: describing the employee's site specific duties during emergency conditions.

f. Training Evaluation: including a written examination of all material concerns in the training course.

4.2 Refresher Training

Regular refresher training in basic hazard awareness shall be provided to employees at least annually.

4.3 Special Training

Many standards promulgated by OSHA explicitly require the employer to train employees in specific health and safety aspects of their jobs. Some OSHA standards require employers to limit certain job assignments to employees who are "certified", "competent", or "qualified", meaning that they have had special previous training. Examples of job assignments that require special training include, but are not limited to:

a. Welding, cutting and other hot work.
b. Confined space entry.
c. Fork lift truck operation.
d. Hazardous materials handling (e.g. - PCB's).
e. First aid and CPR.
f. Fire fighting.
g. Compressed gas and compressed air equipment use.

4.4 Site Safety Officer Training

The minimum requirements for designation as a Site Safety Officer include successful completion of an approved training program and a minimum of two years work experience in the areas of hazardous chemical handling, transportation and disposal.

4.5. Employee Notification/Information

The Site Safety Officer shall provide proper employee information and notification including air sampling results and material safety data sheet information to all affected site works.

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4.6. Recordkeeping

The Site Safety Officer or his designee shall maintain appropriate training records on site, accordance with approved requirements.

5.0 GENERAL SAFE WORK PRACTICES

5.0.1 Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand to mouth transfer and ingestion of material is prohibited in any area where the possibility of contamination exists.

5.0.2 Hands must be thoroughly washed upon leaving a contaminated or suspected contaminated area before eating, drinking, or any other activities transpire.

5.0.3 Employees shall be required to shower at the end of the work shift whenever decontamination procedures for outer garments are in effect.

5.0.4 Legible and understandable precautionary labels shall be prominently affixed to containers of materials, mixtures, scrap, wastes, debris, and contaminated clothing.

5.0.5 Contaminated protective equipment shall not be removed from the regulated area until it has been cleaned or properly packaged and labeled for disposal.

5.0.6 Removal of materials from protective clothing or equipment by blowing, shaking, or any other means which may disperse materials into the air is prohibited.

5.0.7 Portable or fixed emergency shower/eyewash stations shall be strategically located throughout the regulated area.

5.0.8 A deluge shower or hose and nozzle shall be available in the Contamination Zone to wash down heavily contaminated personnel before doffing protective clothing.

5.0.9 Personnel will be cautioned to inform each other of subjective symptoms of chemical exposure such as headaches, dizziness, nausea and irritation of the respiratory tract, eyes, or skin.

5.0.10 No excessive facial hair which interferes with a satisfactory fit of the mask-to-face seal, will be allowed on personnel required to wear respiratory protective equipment.

5.0.11 All respiratory protection selection, use, and maintenance shall meet the requirements of 29 CRF 1910.134 and recognized consensus standards (AIHA, ANSI, NIOSH).

5.0.12 Adverse climatic conditions, heat and cold, are important considerations in planning and conducting site operations. The effects of ambient temperature can cause physical discomfort, loss of efficiency, personal injury, and increased accident probability. In particular, heat stress due to protective clothing decreasing body ventilation is an important factor. One or more of the following recommendations will help reduce heat stress. Their applicability is dependent on evaluating the climatic conditions specific to the operations.

a. Provide plenty of liquids to replace loss of body fluids. Employees should replace water and salts lost from sweating. Use either a 0.1% salt water solution, more heavily salted foods, or commercial mixes such as Gatorade. The commercial mixes may be preferable for employees on low sodium diets.

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b. Establish a work schedule that will provide sufficient rest periods for cooling down. This may require shifts of workers when wearing suits and SCBA.

c. Cooling devices, such as vortex coolers and cool vests, may be worn under suits.

d. Establish work regimes consistent with the ACGIH Guidelines.

e. Provide employee monitoring consistent with the OSHA guidelines.

5.0.13 Cold stress control measures will be prescribed and implemented, as necessary.

6.0 PERSONAL PROTECTIVE EQUIPMENT

6.1 General

Selection of appropriate personal protective equipment will be based on the contaminant type(s), concentration(s), and routes of exposure. Selection of appropriate protection levels will consider all potential exposures to provide adequate worker protection.

The major objectives of the Personal Protective Equipment programs are to select equipment appropriate to and approved for the hazards; to ensure that the devices are introduced to users with a clear and complete explanation of their protection value and method of proper use; and to assign supervisory responsibility ensuring proper use and continued maintenance of the devices.

6.2 Levels of Protection and Equipment Requirements

Appropriate personnel protection shall be worn according to pre-determined contamination exposure levels. The required safety equipment and clothing must be available on-site before work is to begin. Protective equipment and criteria is provided below for Levels A, B, and C.

6.2.1 Level A: Level A indicates that the highest degree of both respiratory and skin protection is required. Examples of such situations include:

- Unknown Contaminants

- high dermal hazard contaminants (acids, bases, chlorine, etc.

Level A equipment:

- Open circuit positive pressure SCBA.
- Totally encapsulating suits (boots and gloves attached).
- Chemically resistant inner gloves.
- Chemically protective boots with steel toe and shank worn over suit boot.
- Chemically resistant outer gloves.
- Coveralls worn under suit.

6.2.2 Level B:

Level B indicates that the highest degree of respiratory protection is required, but site materials do not present a danger to small unprotected areas of the skin. The criteria for Level B includes:

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- Atmospheres are "immediately dangerous to life and health" (IDLH).
- Oxygen deficient atmosphere.
- Exposure of unprotected parts of body is unlikely.

Level B Equipment:

- Open circuit positive pressure SCBA or Type C hoseline pressure demand respirator with escape unit.
- Two-piece, hooded, chemically resistant suit.
- Chemical resistant inner gloves.
- Chemical protective outer gloves.
- Chemically protective outer boots with steel-toe and shank.
- Two-way radio communications.
- Hard hat.
- Face shield.

6.2.3 Level C:

Level C indicates that required respiratory protection is less than levels A and B. Criteria for Level C is as follows:

- Vapor reading between 0 ppm and 5 ppm above background and not dangerous to life and health.

- Exposure of unprotected parts of the body is unlikely.

- Oxygen levels above 19.5%

Level C Equipment may include:

- Air purifying respirator (MSHA/NIOSH approved).
- Chemical resistant clothing.
- Overalls and long sleeved jacked or coveralls.
- Two-piece hooded, chemically resistant splash
- Chemically protective outer gloves.
- Chemically resistant inner gloves.
- Fire resistant cloth coveralls.
- Hard hat.
- Face shield.
- Chemically protective outer boots.
- Chemically protective inner boots with steel-toe and shank.
- Two-way radio communications or work done on "buddy" system.

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7.0 WORK ZONES AND DECONTAMINATION PROCEDURES

7.1 General

To reduce the possibility of employee exposure or movement of contaminants into clean areas, the following work practices are employed:

a. Setting up security or physical barriers to exclude unnecessary personnel from the general area.

b. Minimizing the number of personnel and equipment on site consistent with effective operations.

c. Establishing work zones within the site.

d. Establishing control points to regulate access to work zones.

e. Conducting operations in a manner to reduce the exposure of personnel and equipment.

f. Minimizing the airborne dispersion of contaminant(s).

g. Implementing appropriate decontamination procedures.

7.2 Field Operations Work Areas

Work areas (zones) will be established based on anticipated contamination. Within these zones prescribed operations will occur utilizing appropriate personal protective equipment. Movement between areas will be controlled at check points. The planned zones are discussed below:

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7.2.1 The Exclusion Area is the innermost area of three concentric rings and is considered contaminated, dirty or "hot". An entry checkpoint will be established at the periphery of the Exclusion Area to control the flow of personnel and equipment between the zones, and to ascertain that the entry and exit procedures are followed. Subsequent to initial entry and as the project proceeds, the Exclusion Boundary will be readjusted based on observations and contamination measurements. The boundary will be physically secured and posted.

7.2.2 Contamination Reduction Area

Between the Exclusion Area and the Support Area is the Contamination Reduction Area. The purpose of this zone is to provide an area to prevent or reduce the transfer of contaminants which may have been picked up by personnel or equipment leaving the Exclusion Zone. Personnel and equipment decontamination occurs in the contamination Reduction Area.

The boundary between the Support Area and the Contamination Reduction Area is the "contamination control line". This boundary separates the possibly contaminated area from the clean zone. Entry into the Contamination Area from the Support Area will be through an access control point.

Personnel entering the Contamination Reduction Area will be wearing the prescribed personal protective equipment for activities in the Exclusion Area. Exiting the Contamination Reduction Area to the Support Area mandates the removal of any suspected, or known, contaminated personal protective equipment and compliance with the decontamination procedures. The boundary between the Contamination Reduction Area and the Exclusion Area is the "hot line" and access control station. Entrance into the Exclusion Area requires the wearing of the prescribed personal protective equipment.

7.2.3 Support Area

The Support Area is the outermost of the three rings and is considered a non-contaminated or clean area. It contains the Command Post and field headquarters trailer for field operations and other elements necessary to support site activities. Normal street work clothes are the appropriate apparel within this zone. The Support Area will also contain parking facilities and a materials receiving area.

8.0 DECONTAMINATION PROCEDURES

8.1 Introduction

As part of the system to prevent or reduce the physical transfer of contaminants by people and equipment from on-site, safety procedures will be instituted for decontaminating anything leaving the Exclusion Area and Contamination Reduction Area. These procedures include the decontamination of personnel, protective equipment, monitoring equipment, clean-up equipment, etc.. Unless otherwise demonstrated, everything leaving the Exclusion Area should be considered contaminated and appropriate methods established for decontamination. In general, decontamination at the site consists of washing all equipment, personnel, protective equipment, etc., with a detergent/water solution. If contaminants are known, then a specific detergent and solvent can be used for decontamination. The spent solution contaminated clothing, brushes, sponges, containers, stands, etc., used in the decontamination process will, until shown otherwise, be considered contaminated and must be properly disposed of. Disposal will involve placing all contaminated articles in DOT specified drums, affixing proper labels, and disposal as a hazardous waste.

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8.2 Personnel Decontamination

ENRAC may mobilize personnel decontamination trailers (PDT's) to the site as required for personnel decontamination. The PDT is a self-contained unit which contains facilities for employee showering and changing to street or clean clothes. Once on-site, the PDT forms the control for the worker access to the exclusion area. In order to enter the exclusion area, all personnel and visitors will be required to proceed through the PDT to don the appropriate level of personal protection equipment.

At the end of a shift, and whenever leaving the exclusion zone, all personnel will be required to remove protective equipment and discard disposable garments and equipment in drums for disposal as hazardous waste. Reusable equipment will be pressure washed and will remain in the contamination reduction zone. All wash water generated from this process will be containerized for proper handling and disposal. All personnel will shower and change into clean clothes before leaving the PDT.

9.0 EMERGENCY CONTINGENCY PLAN

9.1 At least one qualified person will be designated to serve as Emergency Coordinator. A list of suitable alternatives designated as substitutes will be available should the primary Emergency Coordinator be unavailable. Duties of the Emergency Coordinator(s) include:

9.1.1 Assessing situations to determine whether an emergency exists;

9.1.2 Directing all efforts in the area including evacuating personnel and minimizing property loss;

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9.1.3 Ensuring that outside emergency services such as fire departments, police, ambulance, and hospitals are notified when necessary;

9.1.4 Directing the shutdown of site operations when necessary;

9.1.5 Notifying regulatory agencies as necessary.

9.2 A list of key response personnel, including after-hour telephone numbers, for all response groups having responsibility for the site will be available on the site.

9.3 Site conditions which would require implementation of the plan, include, but are not limited to:

9.3.1 Fire or explosion on-site.

9.3.2 Serious employee injury.

9.3.3 Accumulation of combustible gases or vapors at concentrations greater than background.

9.3.4 Oxygen concentration below 19.5%.

9.3.5 Unsafe working conditions, such as inclement weather, or hazardous material releases.

9.4 Wind direction indicators may be placed on site, and will be reviewed with all personnel on a daily basis.

9.5 Specific written procedures will be posted and followed when there is release of hazardous materials, 9.6 Specific written procedures will be written for emergency site evacuation. The procedure will include evacuation routes, designated assembly areas, and personnel accounting procedures.

9.7 Specific written procedures will be written and followed by employees who are designated to remain on-site to perform (or shut down) critical site operations before they evacuate.

9.8 Rescue and medical duties will be determined for those employees who are designated to perform them.

9.9 Available emergency equipment, such as SCBA's, first aid kits, fire extinguishers, emergency showers/eye-washes, etc. will be indicated on site diagrams.

9.10 Specific communication procedures will be followed by all personnel with two-way radios.

9.11 Procedures will be in place for contacting the necessary regulatory agencies.

10.0 EMERGENCY RESPONSE PLAN

10.1 Site Emergency Warning System

One or more warning systems may be utilized, depending on the worksite conditions or emergency involved. These include:

a. Verbal communications.

b. Verbal communications assisted with a bull horn.

c. Radio communications.

d. Vehicle horns.
e. Portable hand-held compressed gas horns.
f. Site siren or loud speaker system.

Verbal instructions with or without amplification assistance are used to deal with specific incidents.

Radio communications are used on-site to give instructions and directions. Emergency radio communications are prefixed as such and have priority over operations communications.

Horn signals are used to signify an emergency warning.

One long blast is used on-site to signify emergency evacuation of the immediate work area to a predetermined location upwind, where a head count will be taken and further instructions given.

Repeated short blasts are used on-site or from an off-site location to signify evacuation of all personnel from the site to the hot line where further instructions will be given after a head count is taken.

10.2 Emergency Equipment

The following equipment shall be available at the work sites depending on the nature of the remedial activities to be performed:

a. Fire extinguishers - dry chemical.
b. First aid kits (including chemical burn kit).
c. Emergency oxygen kit.
d. Emergency shower kit (pressurized). CER 007651
e. P.D.T. (personal decontamination trailer).

f. Non-sparking tool kit.

g. Fire blankets.

h. Litters.

i. Portable two-way radio equipment.

j. Combustible gas and oxygen detector/alarm.

k. Organic vapor detection instruments (photoionization detector or flame ionization detector)

l. Inorganic vapor detector tubes and associated air pumps.

m. Hand-held compressed gas horns.

n. Bull horns.

o. Appropriate spill cleanup supplies and equipment.

10.3 General Emergency Procedures

In case of an emergency or hazardous situation, the team member that observes this condition shall immediately give the alarm.

a. Upon hearing an alarm, all non-emergency communications will cease and the member giving the alarm will proceed to give the Project Manager all pertinent information.

b. Actions to be taken will be dictated by the emergency.

c. Power equipment will be shut down and operators will stand by for instruction.

d. Injured personnel will be transported to the Personnel Decontamination Trailer (PDT).

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e. ENRAC Command Post (CP) will be notified immediately.

f. In case of a fire, explosion, or hazard alarm, individuals will proceed immediately to pre-assigned safe sites.

g. Upon arrival at the safe sites, a complete head count will be given to Project Manager and individuals will stay at the safe site until the area is secured.

10.4 Personal Injury

If an injury occurs due to an accident or exposure to a hazardous substance, the ENRAC CP will be immediately notified by radio. The Site Safety Officer will be given all appropriate information concerning the nature and cause of the injury so that treatment preparations can be initiated. The injured person will be transported to the hot line where appropriate decontamination, first aid, and treatment can begin. The Project Manager will be informed and will investigate the cause of the injury and make any necessary changes in work procedures.

10.5 Air Monitoring Plan

The objective of ENRAC air monitoring programs is to measure potential volatile emissions into the ambient air surrounding a remedial site. An air monitoring program is designed to assess both real-time and time-weighted concentrations of volatile pollutants. Monitors are placed downwind of the work area in order to measure concentrations of pollutants that may be released from the site to surrounding areas. Secondly, vapor concentrations are measured in the immediate vicinity of each exhumation and activity to ensure that workers are not exposed to harmful levels of airborne contaminants. Finally, to further protect the health and safety of site

personnel, organic vapor badges (3M or equivalent), may be placed on all on-site individuals to monitor their exposure to airborne organics. Data from these monitors are interpreted and analyzed with respect to the above objectives.

10.6 Ambient Monitoring Contingencies

When ambient monitoring on the downwind edge of the site indicates higher than background levels of any contaminant, the Safety Officer and Project Manager will immediately determine the cause, make changes to work practices or procedures, and if necessary, make changes in site layout (i.e., change the location of the CP, decon area, or Exclusion Area), warn unprotected personnel to evacuate or don protective equipment, and coordinate with local authorities to effect off-site evacuation, as required.

Chemical Waste Management, Inc.
ENRAC Midwest Region
7250 West College Drive
Palos Heights, Illinois 60463
(708) 361-8400

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